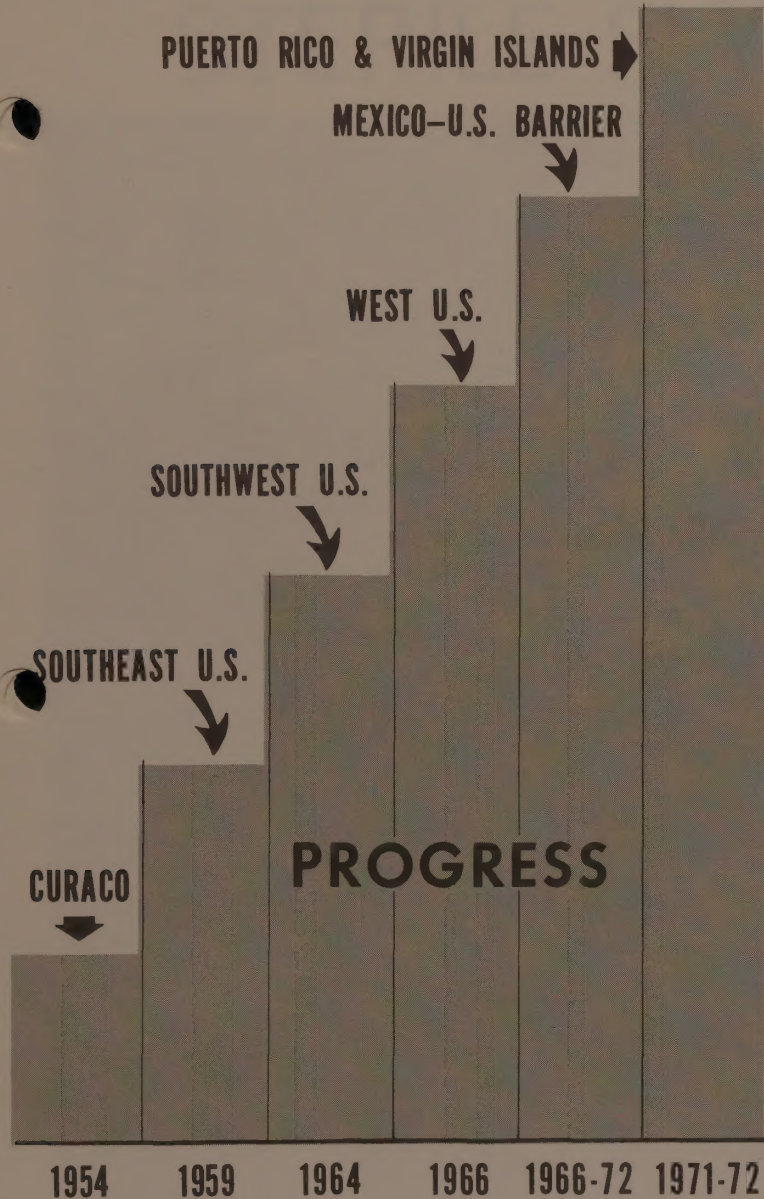


SCREWWORM ERADICATION:

NEW GOAL: MEXICO

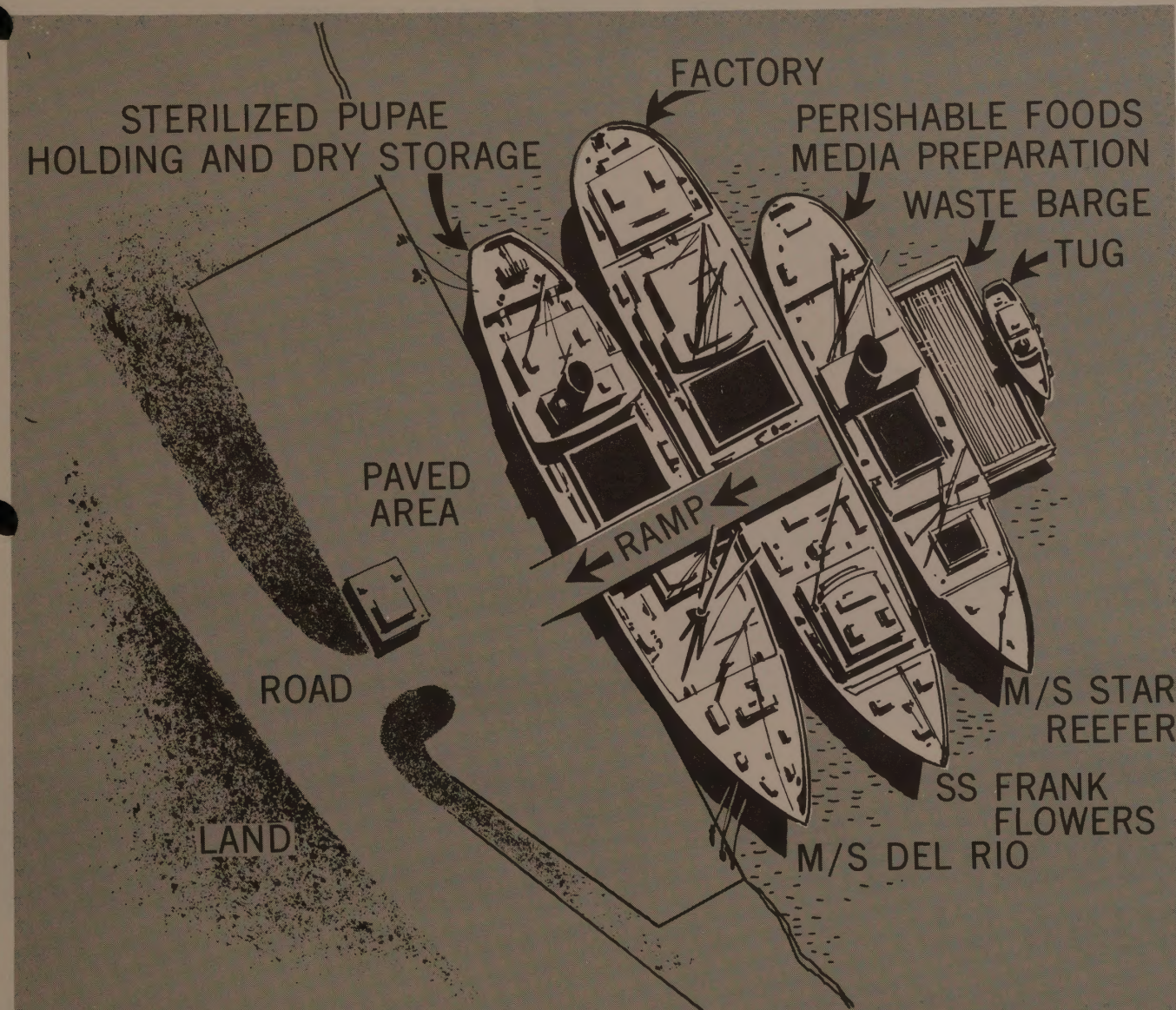


EVENTUAL COST REDUCTION TO
1.8 MILLION PER YEAR

SCREWWORM ERADICATION:

COOPERATIVE EFFORT WITH MEXICO

STERILE FLY FACTORY



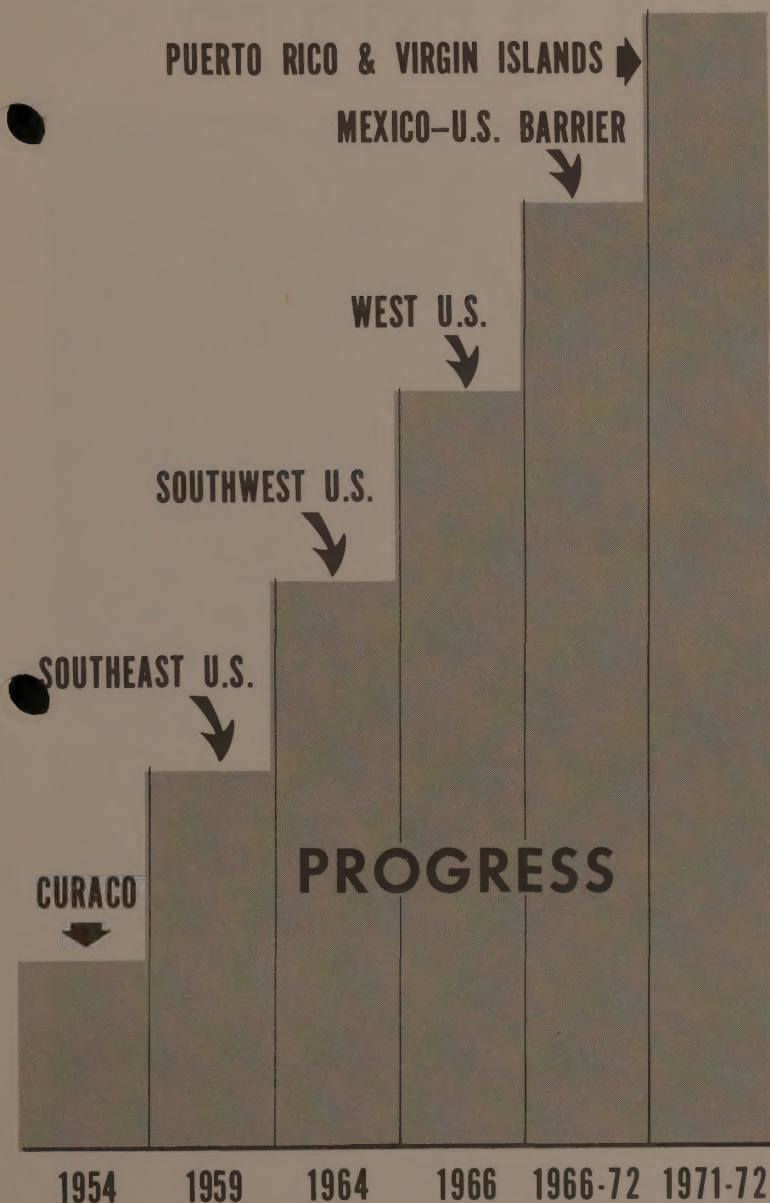
ADVANTAGES:

- **ELIMINATE ALL SCREWWORM LOSSES FROM U.S.**
- **REDUCE COST OF OPERATING BARRIER BY $\frac{2}{3}$**

Veterinary Services
Animal and Plant Health Service
U.S. DEPARTMENT OF AGRICULTURE

SCREWWORM ERADICATION:

NEW GOAL: MEXICO



**EVENTUAL COST REDUCTION TO
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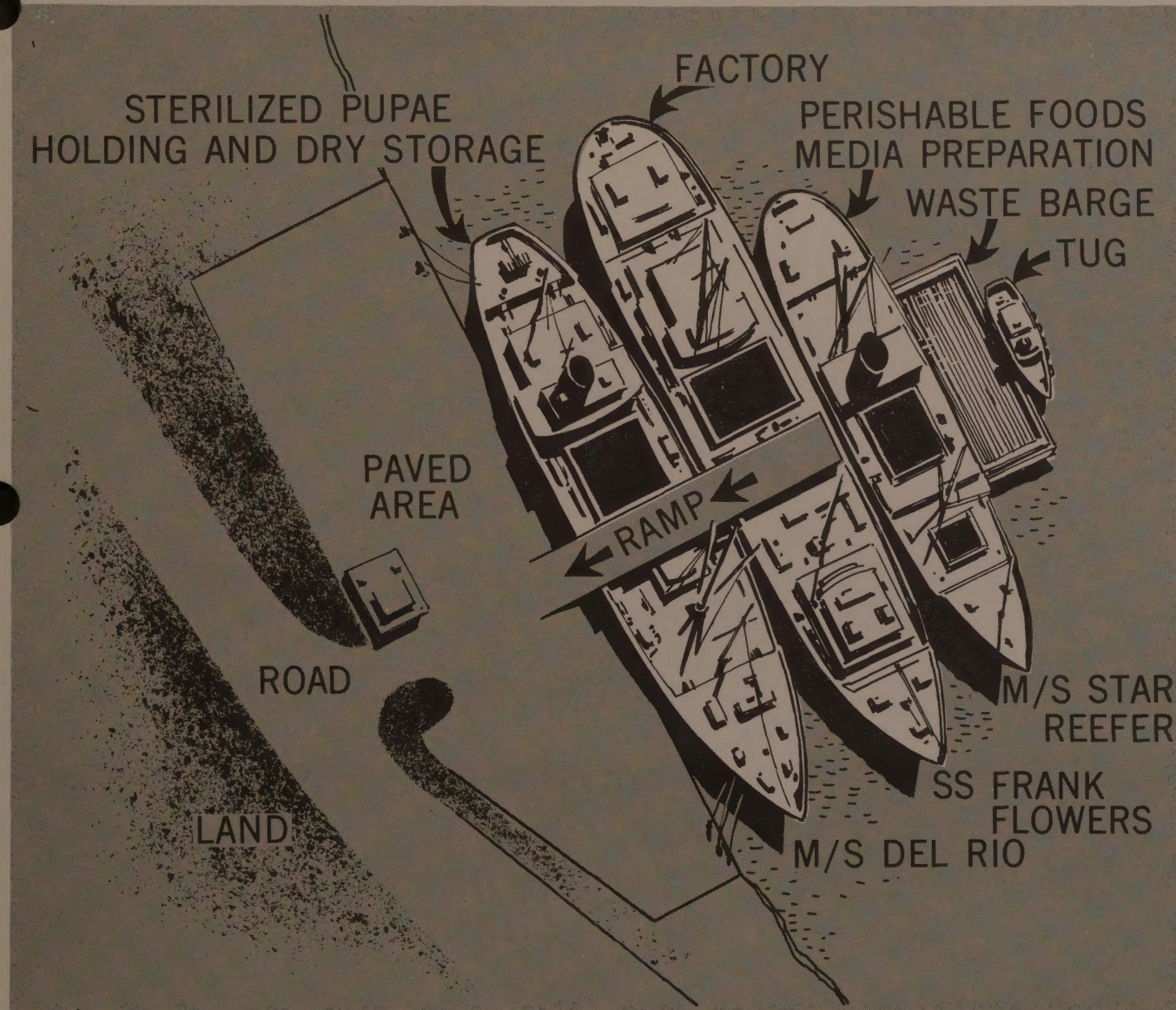
TO WHOM THE AREA
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DIRECTED

NEW GOVT: MEXICO

SCREWWORM ERADICATION:

COOPERATIVE EFFORT WITH MEXICO

STERILE FLY FACTORY



ADVANTAGES:

- **ELIMINATE ALL SCREWWORM LOSSES FROM U.S.**
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Veterinary Services
Animal and Plant Health Service
U.S. DEPARTMENT OF AGRICULTURE



STERITE FLY FACTORY

COOPERATIVE EFFORT WITH MEXICO

SECRETARY OF AGRICULTURE

U.S. DEPARTMENT OF AGRICULTURE
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE
WASHINGTON, D.C.

REPORT ON THE
USE OF STERITE
FLIES IN THE
CONTROL OF THE
MEXICAN PEST

REPORT NO. 12
AT SECRETARIAT
• ELIMINATE

ADDITIONAL:

~~Return to J.C. Bastien~~
~~For E. A. Taylor~~

3.

Eg: I Xeroxed this for
you and Dr. Cox. Even though you
are probably too busy to read it all,
take time to study pages 11 and 12.
This is a really important paper.

BEHAVIORAL ASPECTS OF MASS-REARING OF INSECTS

BY

E. BOLLER

Extrait d'Entomophaga - Tome 17 - 1972
Librairie Le François
91, boulevard St-Germain - Paris-6°

BEHAVIORAL ASPECTS OF MASS-REARING OF INSECTS (*)

BY

E. BOLLER

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The present situation and objectives of mass rearing insects are reviewed under the aspect of behavior. The highest degree of "typical" behavior is required in those species that have to compete with their natural counterparts in the field. Selection pressure and conditioning during the process of mass rearing might alter the behavior of the organisms produced under artificial conditions and cause failures of field-releases. Problems that warrant more considerations are displacement failure to reach natural counterparts and the possibility of the evolution of new pest species. A sequence of actions is suggested for establishing a quality control program that elucidates the behavioral status of laboratory-reared strains.

The fact that insect behavior has been incorporated in this symposium on the implications of mass-producing insects is a symptom of the changing outlook in applied entomology in general and pest control in particular. It is an indication that the modern approaches to pest control — such as pest management or integrated control — have not only opened new dimensions and possibilities but have also thrown light on a few serious bottlenecks that hamper the realization of these ideas and concepts. Whereas there is general agreement that one of the fields to be investigated more intensively is ecology — especially in the area of population dynamics — the very closely related and fundamental field of behavior has hardly been touched so far. Only within the last few years have we realized that various aspects of behavior remain to be discovered that may offer excellent means for the manipulation of insect populations to man's advantage. Also we have become more aware of the fact that behavior must be considered one of the most important components in our rearing programs, one that creates major problems.

The task of covering this subject in adequate detail within the limited time available to-day is anything but easy for several reasons: First, the very core of our considerations — namely animal behavior — is a rather

(*) Presented at the symposium O.I.L.B.: "Implications of permanent insect production". Rome, 1st April 1971.

APPENDIX A: RESULTS OF EXPERIMENT 1

1. Introduction

The purpose of this experiment was to investigate the effects of [illegible] on [illegible].

The results of the experiment are presented in Table 1. The data show that [illegible] significantly affected [illegible]. The effect was [illegible] and was [illegible] in magnitude. The results are consistent with the hypothesis that [illegible].

The first part of the experiment was a [illegible] task. The participants were [illegible] to [illegible] the [illegible] of the [illegible]. The results of this task are presented in Table 1. The data show that [illegible] significantly affected [illegible]. The effect was [illegible] and was [illegible] in magnitude. The results are consistent with the hypothesis that [illegible].

The second part of the experiment was a [illegible] task. The participants were [illegible] to [illegible] the [illegible] of the [illegible]. The results of this task are presented in Table 1. The data show that [illegible] significantly affected [illegible].

The results of the experiment are presented in Table 1. The data show that [illegible] significantly affected [illegible]. The effect was [illegible] and was [illegible] in magnitude. The results are consistent with the hypothesis that [illegible].

complex discipline of science and many aspects are far from being understood. Secondly, much of the information about animal behavior is available for other classes of the animal kingdom such as mammals, birds and fish. It therefore is frequently not applicable in all aspects to the problems of invertebrate behavior. Thirdly, what knowledge we do have on insect behavior has been gained from basic research on species that are not necessarily of economic importance (such as *Drosophila*). Therefore information that has a bearing on our specific problems in connection with mass-rearing and domestication are rare and have so far not been dealt with systematically.

For these reasons the present paper is far from being complete. Its main objective is to stimulate further discussion on the important aspect of insect behavior in mass-rearing which in turn might lead to improved quality control procedures.

I. Present situation

The general objective of a mass-rearing program as it can be observed in many laboratories might be summarized by the following citations from two recent handbooks :

"There is every reason to believe that it will be feasible to rear many kinds of insect parasites and predators at levels of 1000's or even 10,000's per crop acre to be released as needed for insect control... The screw-worm can be mass-produced at cost levels of about \$-.50/1000 and tropical fruit flies at less than \$-.10/1000... Regardless of the manner in which sterile insects might be employed to control or eliminate insect populations it will be necessary or highly advantageous to develop ways to rear insects in large numbers and at lowest costs possible". (E. F. KNIPLING, 1966.)

Or : "The goal of a mass-culture program is to produce with minimal man hours and space the maximum number of fertile females in as short a time and as inexpensively as possible ("production efficiency")" (FINNEY & FISHER, 1964).

The general emphasis as illustrated by these two representative examples is apparently put on low-cost rearing. To my knowledge there is no comprehensive paper or manual that defines and covers in detail the aspect of quality control. Test procedures for various behavioral traits have been developed in the last few years whenever problems became apparent, but most of them have either not been published or cover only limited aspects of the whole complex of behavioral and ecological problems.

In order to find out more about important behavioral aspects in a mass-rearing program let us first review the possible objectives of mass-rearing and the behavioral requirements of the insects produced.

2.

Objectives of mass-culture

Table 1 shows the corresponding relations.

Summarizing this typical behavioral trait rearing program. The thoses cases where the natural counterparts in

Some features of mass-

Figure 1 shows a when wild strains are substrates (larval diet the first few generations followed by generations indicates that success during the early strain is not adapted to occurs in the F_1 and best results under might be the result of

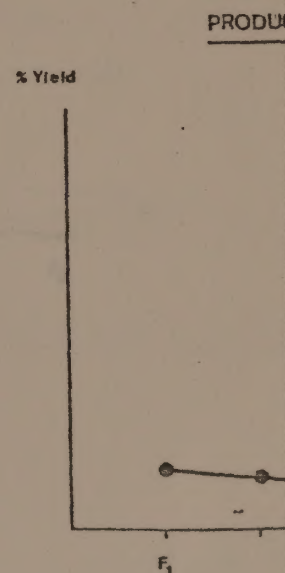


FIG. 1.

2. Mass-rearing and behavior

Objectives of mass-cultures and importance of typical behavior.

Table 1 shows selected examples of rearing purposes and the corresponding relation to the characteristic behavior of the species.

Summarizing this table we can conclude that the importance of typical behavioral traits depends heavily on the purpose of our mass-rearing program. The highest level of "typical behavior" is required in those cases where the mass-reared insects have to compete with their natural counterparts in the field (intraspecific action).

Some features of mass-cultures and their impact on behavior.

Figure 1 shows a production curve that can be frequently observed when wild strains are brought to the laboratory and reared on artificial substrates (larval diet, oviposition devices, etc.). The low recovery in the first few generations or even a decline at the beginning of the rearing process followed by an increasing production after some 5-7 generations indicates that something very drastic takes place. The lack of success during the early stages of colonization suggests that the wild strain is not adapted to laboratory conditions and that intense selection occurs in the F_1 and following generations for individuals that show best results under the given circumstances. This phenomenon might be the result of a selection for individuals physiologically compa-

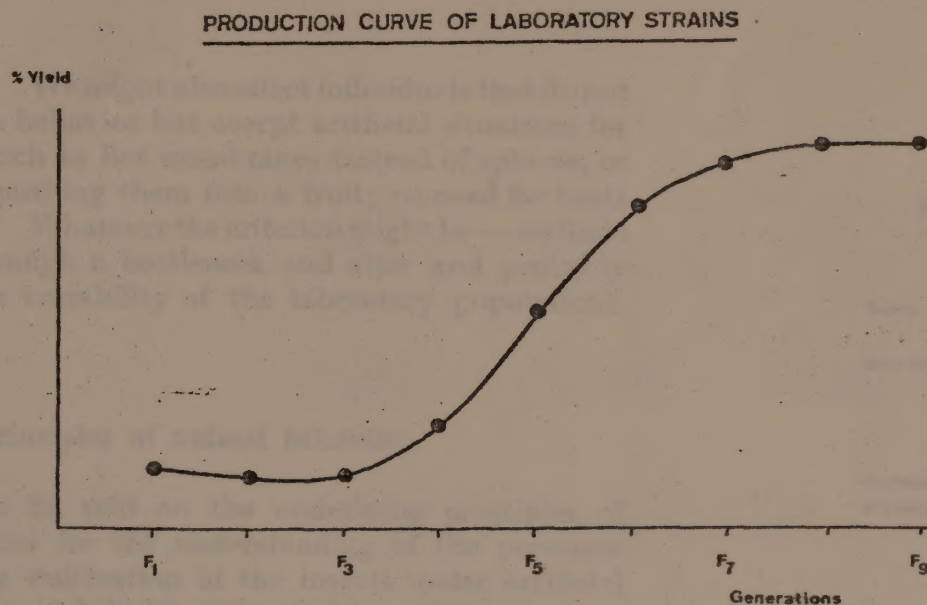


FIG. 1. Production curve of laboratory strains

A. ANALYTICAL CHEMISTRY

1. *Qualitative Analysis* - This branch of analytical chemistry deals with the detection and identification of the various elements and compounds present in a sample. It is a systematic process of testing and observing the sample to determine its composition. The process involves a series of tests, such as flame tests, precipitation reactions, and color reactions, which are used to identify the elements and compounds present in the sample.

2. *Quantitative Analysis* - This branch of analytical chemistry deals with the determination of the amount of a substance present in a sample. It involves the use of various methods, such as gravimetric analysis, volumetric analysis, and instrumental analysis, to measure the concentration of the substance in the sample. Quantitative analysis is essential for determining the purity of a substance and for monitoring the quality of a process.

Fig. 1. Graph showing the relationship between the concentration of a substance and its absorbance.

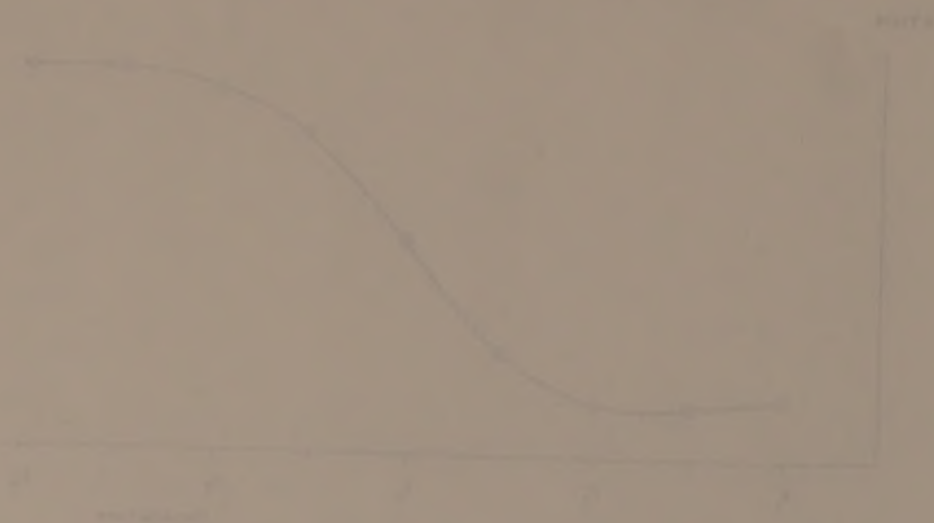


Fig. 2. Graph showing the relationship between the concentration of a substance and its transmittance.

TABLE 1

Objectives of mass-rearing and importance of typical behavior

Objective	Production of raw material for secondary products (virus, pheromones, etc.)	Production of hosts for entomophagous species	Displacement	Parasites and predators	Sterile-insect-technique, "Flushing" genetic suppression
Characteristics of end-product	Dead insects or living substrate	Food source Substrate	Interspecific action		Intraspecific action
Importance of high "production efficiency"	+++++	+++++	++++	++++	+++
Importance of "typical" behavior	+	+	+++	++++	+++++
					Behavior
					Predominant
					component of
					behavioral
					phenotype

tible with an artificial diet. We might also select individuals that do not show a normal oviposition behavior but accept artificial situations for oviposition and mating (such as flat membranes instead of spheres, or dropping eggs instead of pushing them into a fruit; no need for hosts for courtship and mating). Whatever the criterion might be — we force the culture genetically through a bottleneck and alter and probably reduce the level of genetic variability of the laboratory populations.

3. Some principles of animal behavior

A few words have to be said on the underlying principles of behavior which are essential for the understanding of the processes that take place during the cultivation of the insects under artificial conditions. As the science of behavior is rather complex and many aspects have to be dealt with in order to provide a sound background, I am fully aware of the risk that any simplification of this matter will cause heavy criticism from behaviorists who are experts in their field. However, as applied entomologists have to cope with the whole array of aspects of biology, we have to simplify now and then against our will and work out models that can be used in our daily work.

Figure 2 shows behavior. From this behavior has to be analyzed in the genetical make or by environmental result in no alteration

PATHWAYS FROM

Genes
Gene Products
Biochemical and physiological traits
Behavioral traits

FIG. 3. Pat

Table 1

Comparison of mean values and standard deviations for the two groups

Group	Mean	Standard Deviation	Mean	Standard Deviation
Group 1	10.5	2.5	10.5	2.5
Group 2	10.5	2.5	10.5	2.5
Group 3	10.5	2.5	10.5	2.5
Group 4	10.5	2.5	10.5	2.5
Group 5	10.5	2.5	10.5	2.5
Group 6	10.5	2.5	10.5	2.5
Group 7	10.5	2.5	10.5	2.5
Group 8	10.5	2.5	10.5	2.5
Group 9	10.5	2.5	10.5	2.5
Group 10	10.5	2.5	10.5	2.5

The results of the study are presented in Table 1. The mean values and standard deviations for the two groups are compared. The results show that the mean values for the two groups are very similar, and the standard deviations are also very similar. This indicates that the two groups are very similar in terms of the variables being measured.

3. Results of the study

The results of the study are presented in Table 1. The mean values and standard deviations for the two groups are compared. The results show that the mean values for the two groups are very similar, and the standard deviations are also very similar. This indicates that the two groups are very similar in terms of the variables being measured.

Figure 2 shows a simplified model of the basic components of behavior. From this model one can conclude that any change in behavior has to be analyzed as to whether it has been caused by changes in the genetical make-up of the population (e.g. by repeated selection) or by environmental influences such as conditioning or learning which result in no alteration of the genome.

COMPONENTS OF BEHAVIOR

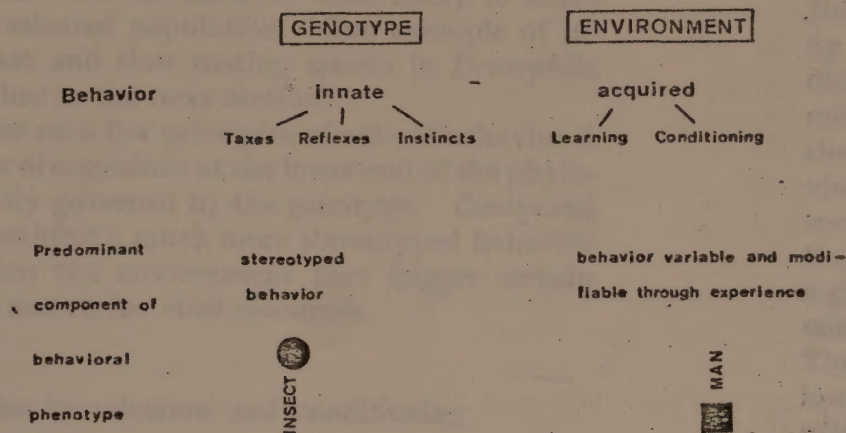


FIG. 2. Components of behavior

PATHWAYS FROM GENES TO BEHAVIORAL TRAITS (after Parsons 1957)

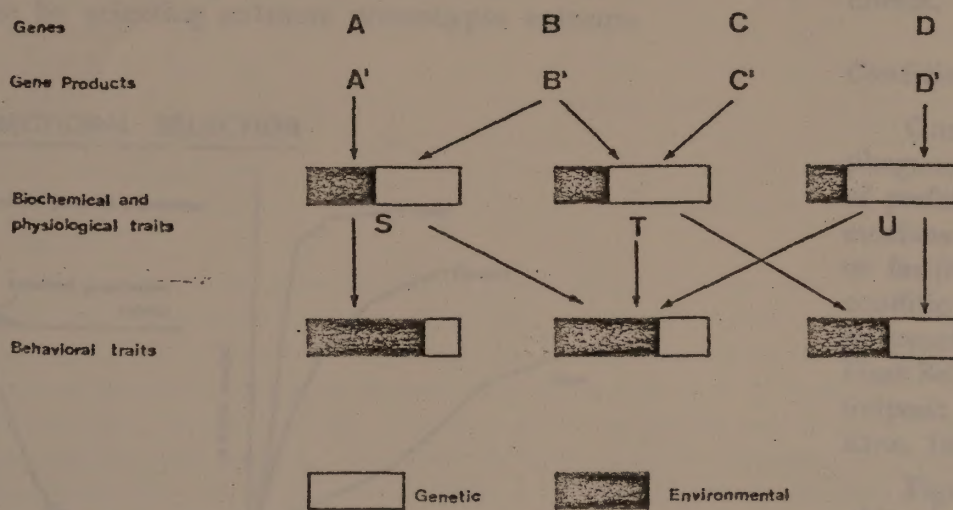


FIG. 3. Pathways from genes to behavioral traits

Figure 2 shows a simplified model of the three components of behavior. The model was constructed to show the relationship between the three components of behavior. The model is based on the assumption that the three components of behavior are interrelated and that the behavior of the individual is determined by the interaction of these three components.

CONCEPTUAL MODEL OF BEHAVIOR



Figure 2. Conceptual Model of Behavior

INTERACTIVE MODEL OF BEHAVIORAL CHANGE



Figure 3. Interactive Model of Behavioral Change

A model showing the pathways from genes to specific behavioral traits is given in figure 3. Single genes in most cases influence not one but several phenotypic traits in more or less obvious ways. A selection for a given behavioral trait is therefore most likely to affect other characteristics of the selected population. One example of interest is the selection for fast and slow mating speeds in *Drosophila* which will be explained further in the next section.

Summarizing this chapter on a few principles of animal behavior it is of interest that the behavior of organisms at the lower end of the phylogenetic series is predominantly governed by the genotype. Compared with higher animals, insects exhibit a much more stereotyped behavior according to the stimuli from the environment that trigger certain responses in the insect in its search for vital resources.

4. Changing behavior by selection and conditioning

Selection.

The genetic material can be manipulated by selecting individuals at either extreme of a normally distributed quantitative trait of interest in the hope of establishing specific desirable lines in subsequent generations (fig. 4a). If the trait has some genetic basis there should be a response to selection, since by selecting extreme phenotypes extreme

genotypes will be selected on the heritability and

An example is *Drosophila melanogaster* by this selection and diate. After 25 generations in the fast strain shows the situation in vioral consequences in context. Activity during flies to an arena a given time period as more activity of this. Thus the fast mating low level of "generalized mating strain. Under sumably well balanced be undesirable. This programs where selection sometimes unconscious mass-rearing conditions effects.

Conditioning.

One of the characteristics of phagous insects is the of preference has provoked discussions for the last six or facilitate host shift conditioning or habituation is sometimes suggested. Host Selection Principles oviposit on the plant species (KINS, 1917).

Figure 5 shows an example for peppermint demonstrated in figure induced by environmental the insect as does selection the conditioned trait in generation there is also (adult) according to the

Other examples of *Nemeritis canescens* the

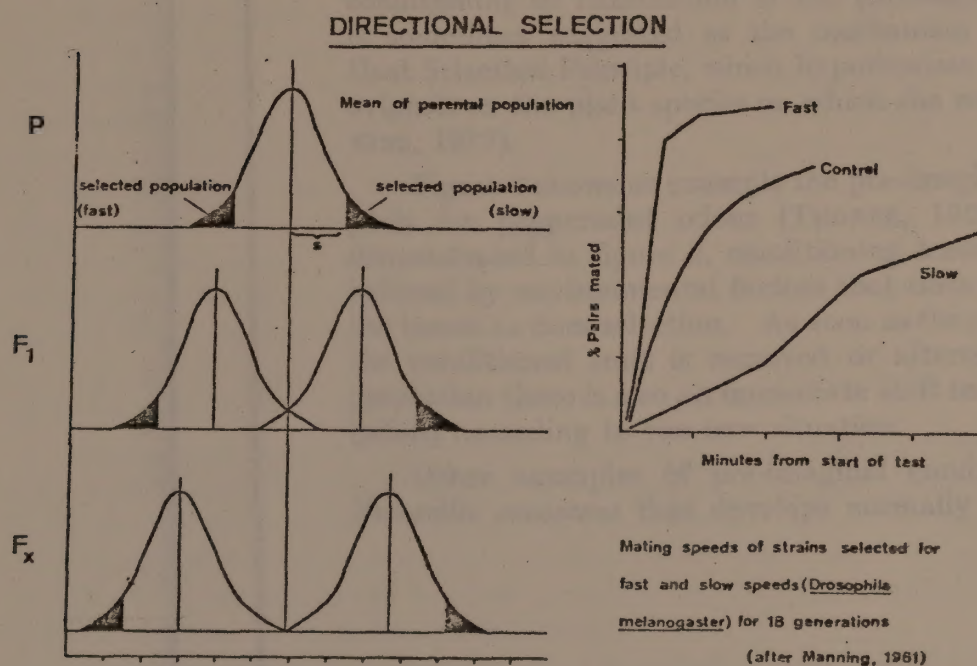


FIG. 4a. Directional selection. FIG. 4b. Selection for mating speed in *Drosophila*.

genotypes will be selected. The magnitude of the response will depend on the heritability and the selection differential S (fig. 4a).

An example is the selection for fast and slow mating speed in *Drosophila melanogaster* (MANNING, 1961). Both sexes were affected by this selection and the response to this procedure was almost immediate. After 25 generations the mean mating speed was about three minutes in the fast strains and eighty minutes in the slow lines (fig. 4b shows the situation in the 18th generation). MANNING analyzed the behavioral consequences of that selection which is of special interest in this context. Activity differences between strains were measured by admitting flies to an arena where the number of squares entered by a fly in a given time period was scored. The slow mating lines exhibited much more activity of this type, which MANNING called "general activity". Thus the fast mating lines had a high level of "sexual activity" and a low level of "general activity" with the reverse situation for the slowly mating strain. Under natural conditions these two components are presumably well balanced as over-responsiveness in either direction would be undesirable. This example might have some value for mass-rearing programs where selection for a given behavioral trait is performed sometimes unconsciously during the process of adapting insects to mass-rearing condition without considering the possible negative side effects.

Conditioning.

One of the characteristics of the feeding behavior of many phytophagous insects is the rigid specificity of diet. The origin of differences of preference has provided material for evolutionary studies and discussions for the last six decades. One mechanism which might enhance or facilitate host shifts is — besides selection as outlined above — conditioning or habituation of the preimaginal stages. Conditioning is sometimes suggested as the mechanism underlying the Hopkins Host Selection Principle, which hypothesizes that the female tends to oviposit on the plant species on which she was raised as a larva (HOPKINS, 1917).

Figure 5 shows as example the pre-imaginal conditioning of *Drosophila* for peppermint odour (THORPE, 1939; MANNING, 1967). As demonstrated in figure 2, conditioning leads to a change of behavior induced by environmental factors that does not alter the genotype of the insect as does selection. As soon as the responsible stimulus for the conditioned trait is removed or altered in a subsequent larval generation there is also an immediate shift in the behavioral phenotype (adult) according to the new situation.

Other examples of pre-imaginal conditioning are the parasite *Nemeritis canescens* that develops normally as larva on *Ephestia* but

attacks *Meliphora* after being reared on that host (THORPE & JONES, 1937) and two Lepidoptera (*Manduca sexta* and *Heliothis zea*) fed on different host plants that showed a clear preference for the plant previously eaten (JERMY *et al.*, 1968).

CONDITIONING OF DROSOPHILA FOR PEPPERMINT ODOUR

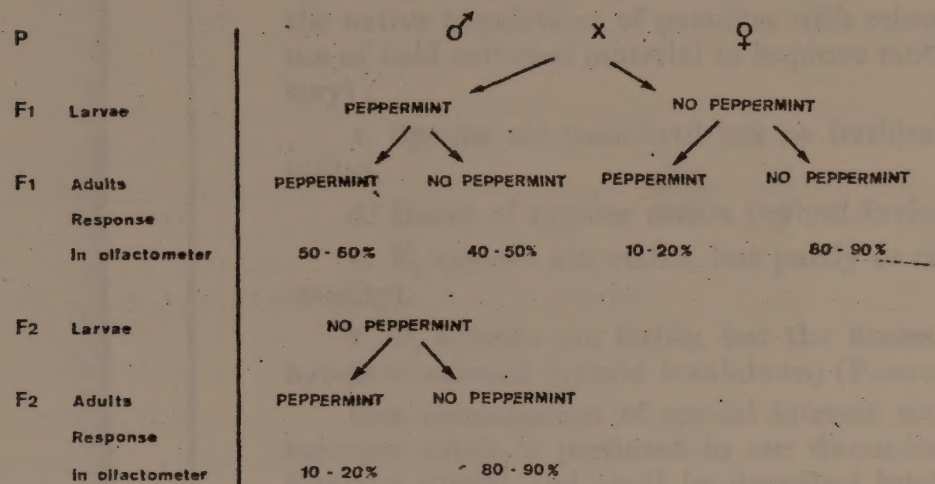


FIG. 5. Conditioning of *Drosophila* for peppermint odour.

SCHOONHOVEN (1967) showed that larvae of *Manduca sexta* grown on artificial diets are less restrictive in their plant choice than normal and will accept some usually rejected plants. This point deserves to be considered in any mass-rearing program that utilises artificial diets that do not contain host specific token stimuli. One example might be the *Rhagoletis* spp. that must find their sexual partners on their specific hosts. The absence of a token stimulus for their host might alter the orientation mechanisms of the species. This might lead to the eventual evolution of an isolating mechanism which will be further discussed in the next section.

Consequences of altered behavior in laboratory populations.

One important aspect in the mass-rearing of insects under laboratory conditions is the possibility of altered mating behavior leading to a partial sexual isolation with the wild populations. The term "isolating mechanism" was proposed by DOBZHANSKY (1937) as a name for barriers to gene exchange between sexually reproducing populations and was further defined by MAYR (1963).

Considering the various purposes for reared insects the possible isolating mechanisms can be divided into two groups. The first group

includes the three important significance for the re

1. Potential mating e.g. altered periodicity plants with failure to

2. Potential mating

3. Copulation at (mechanical isolation)

The second group failure in those cases w the native populations use of field collected m tory):

4. Sperm are tr (fertility).

5. Death of zygote

6. F_1 zygotes are sterility).

7. F_1 hybrids are hybrid is reduced (hyb

One investigation isolation which is pe EHRMAN (1964) and s isolation between six p from the same initial po at different temperatur isolation had arisen in was evidently a by-pro population built up its its own behavioral phen towards homogamic ma pools to become isola assortative mating is of

The tendency of sh in laboratory population strains. Heterozygous between different enviro fitness factors (e.g. PAR of various strains to diff maintained e.g. by inte which shows certain adva the approach used in m

includes the three important *pre-mating* mechanisms which are of special significance for the release of sterile insects :

1. Potential mates do not meet (isolation in time and space : e.g. altered periodicities of mating activity; conditioning for other host plants with failure to find natural rendez vous sites of the sexes).
2. Potential mates meet but do not mate (ethological isolation).
3. Copulation attempted but no transfer of sperms takes place (mechanical isolation).

The second group includes *post-mating* mechanisms that can cause failure in those cases where fertile insects are to be used (e.g. increasing the native populations of parasites with released laboratory strains or use of field collected material to improve mother stocks in the laboratory) :

4. Sperms are transferred but no fertilization occurs (sperm mortality).
5. Death of zygotes occurs (hybrid inviability).
6. F_1 zygotes are viable, but partly or completely sterile (hybrid sterility).
7. F_1 hybrids are fertile, but the fitness of the F_2 or backcross hybrid is reduced (hybrid breakdown) (PARSONS, 1967).

One investigation of special interest concerning the ethological isolation which is pertinent to our discussion has been reported by EHRMAN (1964) and shall be described briefly. She studied sexual isolation between six populations of *Drosophila pseudoobscura* derived from the same initial population but maintained for several generations at different temperatures. Choice experiments showed that sexual isolation had arisen in the absence of any selection for isolation and was evidently a by-product of genetic divergence. Each laboratory population built up its own unique highly adapted gene complex with its own behavioral phenotype. Sexual isolation is a general tendency towards homogamic matings, and so may lead to a tendency of gene pools to become isolated. Within populations the term positive assortative mating is often used with a similar meaning.

The tendency of shifting towards homozygosity for various traits in laboratory populations is a major problem of inbreeding laboratory strains. Heterozygous individuals show more *behavioral homeostasis* between different environments than homozygous individuals for many fitness factors (e.g. PARSONS & KAUL, 1966, who studied the adaptation of various strains to different temperatures). Heterozygosity can be maintained e.g. by interbreeding various laboratory strains each of which shows certain advantageous behavioral traits. This is similar to the approach used in modern plant and animal breeding.

5. Selected examples of changed behavior in mass-reared insects of economic importance

Dispersal.

- *Anopheles quadrimaculatus* successfully reared in the laboratory for years by reducing the oviposition cage shows decreased flight capacity and adults failed in releasing programs (RAI, 1969).
- *Ceratitis capitata* reared in small cages shows tendency to sedentary behavior ("walking flies").
- *Carpocapsa pomonella* reared at 25° C on apple does apparently not disperse as far as natural moths at lower temperatures. ✓
- There are indications that fruit flies (e.g. *Ceratitis capitata*) reared at optimal constant temperatures do not have the same flight capacity after they have been subjected to low temperatures (+ 6° C) for a few hours (BOLLER, 1971, unpublished).

Search for host and sexual partner.

- *Anthonomus grandis* males produce a less attractive sex-pheromone under crowded laboratory conditions (GAST, 1968).
- FLETCHER *et al.* (1968) report altered female responsiveness of screw-worm flies (*Cochliomyia hominivorax*) to male pheromone.
- Laboratory reared mosquito males (*Anopheles quadrimaculatus*) failed to locate the females in nature (DAME *et al.*, 1964).
- There are indications that sympatric host race formation in the *Rhagoletis* group occurs within a few generations (BUSH, 1969). Can the orientation mechanisms leading the insect to host tree and rendez vous site of the sexes be altered e.g. in *Rhagoletis cerasi* by artificial diets and unsuitable oviposition systems such as flat membranes and egg-dropping?

Mating behavior.

- It is suspected that the mating periods of laboratory reared codling moths (*Carpocapsa pomonella*) and of wild moths are not always well synchronized. Further studies are in progress.
- *Musca domestica* — females of three different strains mated more readily with males of their own strain (FYE *et al.*, 1966).
- Mating behavior of screw-worm flies as affected by differences in strain and size was described by ALLEY & HIGHTOWER (1966) and SPATES & HIGHTOWER (1967). It seems that laboratory adapted male flies that fall within size-classes of screw-worm flies infrequently found in nature are unsuitable for sterile-male releases.

Oviposition.

- As to oviposition (Lepidopteran species and others) it is frequently shown that laboratory show

6. Consequences

It is a common experience that mass-rearing-plant and transfer to natural distances. Unless the native population in the release area, there may have been studied systematically.

Displacement.

MONRO (1966) in his studies on overcrowding of the car (etc.) with additional population. Crowding leads to a critical threshold. This capacity compared with increasing evidence that strains of fruit flies) two populations will means that the wild population distances than normal strong flying type of insects. This theoretical consideration of rearing insects that is with the corresponding

Failure to reach natural

Mono- and oligophagous sexual partners by altered under abnormal laboratory inadequate token stimulus adult host selection behavior effects on a releasing program directly tied to host selection flies might fail to locate

Oviposition.

— As to oviposition well-documented examples are rare. With various Lepidopteran species (*Carpocapsa pomonella*, *Clysia ambiguella* and others) it is frequently observed that wild strains brought to the laboratory show poor oviposition in the first generations.

6. Consequences of releasing insects with atypical behavior

It is a common practice that insects are mass-reared in a central rearing-plant and transported to the release sites over considerable distances. Unless the released insects match closely the behavior of the native population and are reared from strains originating from the release area, there might occur several problems which have so far not been studied systematically.

Displacement.

MONRO (1966) introduced the term "flushing", which means the overloading of the carrying capacity of the environment (food sources, etc.) with additional individuals leading to a break-down of the entire population. Crowding effects lead on the other hand to a higher dispersal rate within the populations which increased their density beyond a critical threshold. If the released insects exhibit a reduced flight capacity compared with their natural counterparts (and there is increasing evidence that this is the case in many laboratory-reared strains of fruit flies) we might speculate that a segregation of the two populations will take place at least to a certain extent. This means that the wild population might be forced to disperse over greater distances than normal and to invade other areas. The selection of a strong flying type of insect could lead to the same effect in reverse. This theoretical consideration points again to the desirable objective of rearing insects that show the *same* characteristics as wild populations with the corresponding variability (no standardized end-products).

Failure to reach natural population.

Mono- and oligophagous species might fail to find their hosts and sexual partners by altered orientation behavior due to conditioning under abnormal laboratory conditions. Incorporating the wrong or inadequate token stimuli into the larval substrate that may condition adult host selection behavior or host acceptance might have serious effects on a releasing program. Example: Where mate selection is directly tied to host selection as in the case of *Rhagoletis* spp., released flies might fail to locate wild mates.

1950

As a result of the above, it is concluded that the results of the present study are in agreement with the results of the previous study. It is suggested that further research be conducted in this area.

3. Comparison of research results with original behavior

It is concluded from the above that the results of the present study are in agreement with the results of the previous study. It is suggested that further research be conducted in this area.

1950

It is concluded from the above that the results of the present study are in agreement with the results of the previous study. It is suggested that further research be conducted in this area.

4. Conclusion and recommendations

It is concluded from the above that the results of the present study are in agreement with the results of the previous study. It is suggested that further research be conducted in this area.

Evolution of new pest species.

The possibility that the genetic polymorphism might be greatly altered by mixing the gene pools of two different regional strains makes it imperative that the possible effects of the hybrids produced be given careful consideration. One problem could be that the hybrids are more vigorous and adaptable than the two parent populations and might invade new ecological niches and expand drastically their distribution range. One example is the case of hybridization between *Dacus tryoni* and *Dacus neohumeralis* reported by LEWONTIN & BIRCH (1966). A second alternative is the formation of a strain that attacks new hosts eventually leading to the formation of a new pest species.

7. New objectives of mass-rearing programs

Considering all these problems centered around the behavior of the insects produced on a large scale under laboratory conditions it becomes evident that the objectives of a mass-culture as they stand to-day might no longer be valid. The highest output at lowest cost might be too expensive if the insects produced do not behave in the field in the same way as the natural populations do. Hence, we might in general agree with the statement of BECK & CHIPPENDALE (1968) who described the objective of mass-rearing plant-feeding lepidopterans as follows :

— Maintenance of an indefinitely self-perpetuating population without attenuation of either viability or reproductive capacity.

— Produce individual insects that are fully capable of competing with members of wild populations in respect to growth-rate, vigour and behavioral characteristics.

However, it is open to debate whether an indefinitely self-perpetuating laboratory population is desirable. This question has to be asked whenever we deal with uni- or oligovoltine species that normally go into diapause. When we recall fig. 1 showing a general production curve of a wild strain in various phases of "domestication", it might be worthwhile to consider a different approach. Polyvoltine species call for an instant supply of high quality insects according to the population densities of the pest in nature at a given moment. Univoltine species, however, must be overflowed with sterile insects only during a relatively short period of time each year. The question is whether it is better to expand the rearing facilities for a short period and aim at a high daily output that can probably be achieved only by a self-perpetuating non-diapausing laboratory strain that has passed through the famous genetical bottleneck and can be reared on artificial substrates. The alternative is a relatively small rearing

facility that produces the latter approach might to a great extent with rearing techniques that based on the selection devote more time and closely simulating the many important behavioral-conforming activities, etc.). The diapause development a considerable length of the necessary number addition it would not behavior that comes reared continuously.

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Traditional com

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Number of fertile
produced per moneta

Criterion : Production

8. How

The following sequ

Step 1 : Define the probl

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method : Adaptation to
sources — host selection
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Step 2 : Take stock.

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facility that produces diapausing insects on a 52-week-basis. This latter approach might have several advantages. First, one could use to a great extent wild strains as mother-stock but is forced to develop rearing techniques that are immediately more successful than methods based on the selection of an adapted strain. Secondly, one could devote more time and attention to rearing the insects under conditions closely simulating those encountered in nature in order to maintain many important behavioral traits (e.g. host-plant token stimuli, behavior-conforming oviposition, larger cages stimulating flight activities, etc.). Thirdly, optimal temperature regimes for regulating the diapause development might allow the stockpiling of material for a considerable length of time. By doing so, it would be possible to have the necessary number of adults ready at the precise moment. In addition it would not be surprising if diapausing insects showed a behavior that comes closer to the natural one compared with insects reared continuously.

What is the production efficiency under these aspects?

Traditional concept

"Production efficiency":
Number of fertile insects
produced per monetary unit

Criterion: Production costs

Postulated concept

Production efficiency:
Ratio of released laboratory
insects to natural insects required
to reach a given objective

Production costs and quality

8. How can we tackle the problem?

The following sequence of actions is one of various possibilities:

Step 1: Define the problem (behavior).

What are the essential aspects of behavior in a chronological order throughout the life-cycle of the species? (e.g. Sterile Insect Release method: Adaptation to field conditions and dispersal — finding food sources — host selection — finding rendez vous sites for the sexual partners — mating — oviposition — survival.

Step 2: Take stock.

What is known and where do we need further information about the behavior? Make priority list according to direct impact on success. Review your quality control procedures and add new tests for essential behavioral traits.

Step 3: Prophylatic actions when starting new colony with wild strains.

— Choose rearing methods that give relatively high yields in the F_1 generation. This avoids strong selection pressure for that small part of the population that is most adapted to artificial conditions and maintains a broad genetically determined variability.

— Do not select too early for features that lead to a standardization of your insects ("high production efficiency" on a mere cost-yield basis). This is especially important for insects that can be reared easily under the most simplified artificial conditions.

— Incorporate "luxury" stimuli in the rearing procedure that have no immediate effect on the yield but might be essential for the maintenance of certain behavioral traits (e.g. "host odour", behavioral conform rendez vous sites, etc.).

— Make the insect's life not too comfortable (remote food sources to induce flight, fluctuating temperatures and humidity for maintaining a high degree of adaptability, etc.).

Step 4: Checking "laboratory strains" (quality control).

— Perform a wide array of behavioral tests for essential traits and compare the results with the respective parameters of wild populations (not only average performance but also variability).

— Perform the quality tests not only under optimal laboratory conditions but also under the extremes similar to those occurring in the field.

Examples:

Flight: Flight capacity (flight distances, flight speed and flight pattern) with flight mills (CHAMBERS *et al.*, 1969; KISHABA *et al.*, 1967; BOLLER *et al.*, in preparation).

Host finding: (especially important for oligophagous species), preference tests for various hosts.

Finding mates: Response to pheromones. Flight to artificial and natural rendez vous sites; fighting intensity between males as an indication for the proper rendez vous site.

Vigour: "General" vigour: Longevity under extreme conditions.

No stress tests (e.g. overloading of cage) because strong individuals are not necessarily exhibiting higher fitness in all aspects (MANNING, 1961).

Sexual aggressiveness: SAG Test (BAUMHOVER, 1965), copulation frequencies and time of mating, insemination rates, ratio tests (laboratory males — wild males — wild females).

Step 5: Curative actions

General: Influences, etc. (HOOPER)
Low flight capacity force insects to move devices, etc.)

— Introduce wild from the flight mill aspects outlined in S

Reduced vigour:

— Make rearing tures and humidity,

— Introduce wild strains with desirable

Step 6: Quality control cages.

Dispersal: Mark

Copulation frequency: isoenzyme-method (Z tion; with sterile insect observation.

Longevity: Mark

Orientation to target range attractants (e.g.

I gratefully acknowledge colleagues with whom I have of Dr. BUSH (visiting scientist) reviewed the manuscript.

Conséquences sur le

La situation présente résumés sous l'aspect du « typique » est exigé pour dans la nature.

La pression de sélection peuvent changer le comportement artificielles et provoquer demandent plus de considération, l'incapacité des individus naturels et la possibilité d'actions est suggérée pour du comportement de souche

Step 5 : Curative action in "abnormal strains".

General : Influence of sterilization, marking and handling procedures, etc. (HOOPER 1970).

Low flight capacity : — Increase cage size of mother stock and force insects to move actively towards vital resources (food, oviposition devices, etc.)

— Introduce wild strains or interbreed strongly flying insects from the flight mill studies (however, give careful consideration to aspects outlined in Section 7.1).

Reduced vigour :

— Make rearing conditions more natural (fluctuating temperatures and humidity, light conditions, etc.).

— Introduce wild strains to restore vigour or interbreed selected strains with desirable behavioral traits.

Step 6 : Quality control of laboratory reared strains in the field or field-cages.

Dispersal : Mark-release - recapture.

Copulation frequencies : with fertile insects in field cages with isoenzyme-method (ZOUROS & KRIMBAS, 1970) or by direct observation; with sterile insects by using markers (ratio tests) or also by direct observation.

Longevity : Mark-release - recapture.

Orientation to target (host, sexual partner, etc.) by using short range attractants (e.g. visual traps, sticky boards, sweeping, etc.)

ACKNOWLEDGMENTS

I gratefully acknowledge the kind cooperation and assistance of many colleagues with whom I had long discussions about this subject — especially that of Dr. BUSH (visiting scientist of the University of Texas at Austin) who critically reviewed the manuscript.

RÉSUMÉ

Conséquences sur le comportement de l'élevage de masse des insectes

La situation présente et les buts de l'élevage en masse des insectes sont résumés sous l'aspect du comportement. Le plus haut degré de comportement « typique » est exigé pour les espèces qui doivent exercer une action intraspécifique dans la nature.

La pression de sélection et le conditionnement pendant l'élevage en masse peuvent changer le comportement des organismes élevés dans des conditions artificielles et provoquer des échecs de lâchers en plein champ. Les problèmes qui demandent plus de considérations au sujet des lâchers sont les facultés de déplacement, l'incapacité des insectes élevés en laboratoire d'atteindre leurs partenaires naturels et la possibilité d'évolution de nouvelles espèces nuisibles. Une série d'actions est suggérée pour examiner la qualité de la production au point de vue du comportement de souches élevées en laboratoires.

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CONTENTS

Original Articles: The Medical Profession and the Public, J. H. Tappan, M.D., 11; The Medical Profession and the Public, J. H. Tappan, M.D., 11; The Medical Profession and the Public, J. H. Tappan, M.D., 11.

DEPARTMENTS

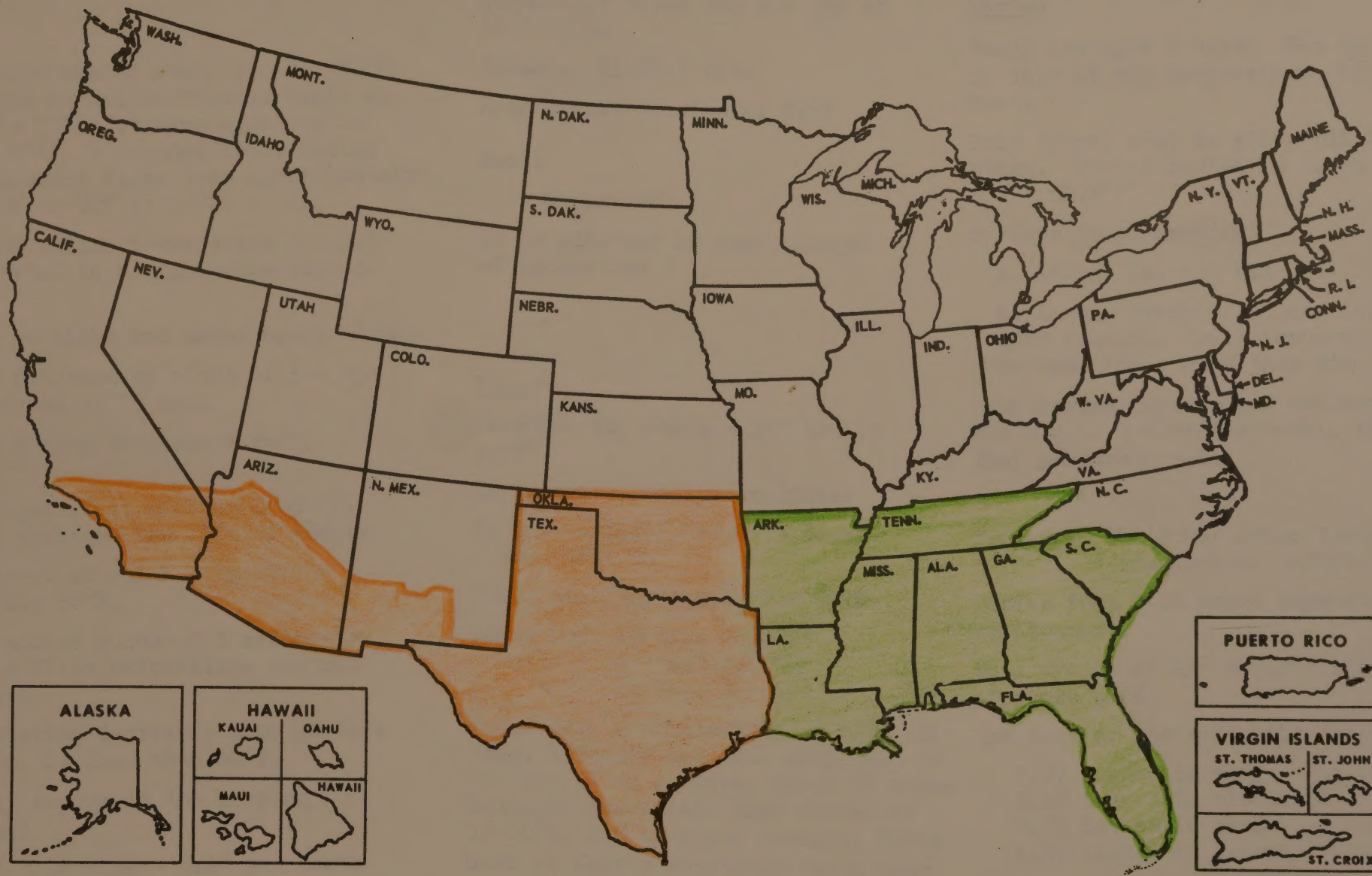
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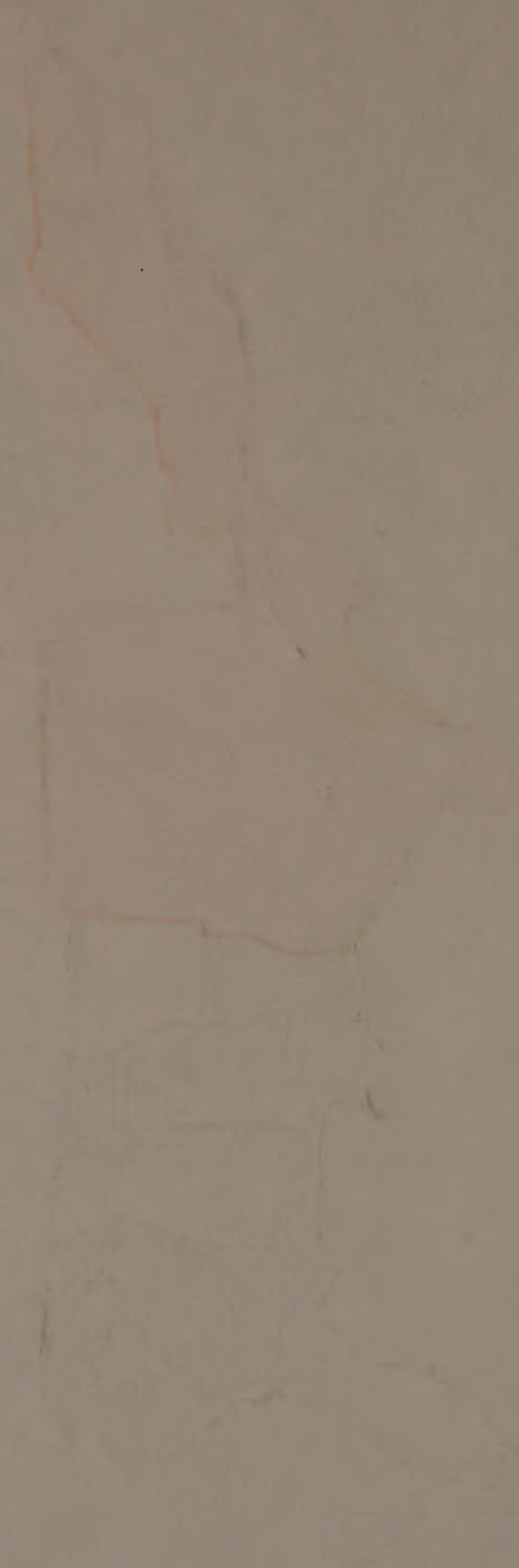
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7/26



 Zone of Recurring Infestation
 Controlled Zone

Controlled Zone
Zone of Protection Investigation



LIFE CYCLE OF THE SCREWORM

Egg Stage

Egg mass - 10 to 393 eggs each

Incubation time: Lab 9 h 34' at 101°-90°F.

Animals 11-21.5 hrs.

Eggs cannot survive at 59°F

Need:

% survival ?

It is affected by temp. length of incubation ?

Pupae

Duration in nature - 167 hrs. (7 days)

In summer - 54 days in winter

In lab. - 142.2 hrs. (5.9 days) for 94°F

760.4 hrs. (31.7 days) for 59°F

Other ref. 10 days for 75°
15 days for 70°
30 days for 60°

Under lab. conditions at 4" with air temp. 18°-83°F and soil temp. 40° to 70° for 41 to 44 days, 36.3% of pupae hatched, rest died. When frozen at 18-20°F, 40% of pupae emerged. Pupae held at fairly construct temp. near 55°F rarely produced adults. The lower the moisture, the higher the emergence between 50 and 60°F.

When valid weather prolongs the pupal stage beyond 50 days, emergence drops to 1 - 2%.

Adult - less than 2 weeks if over 70°F. Feeding and normal activities begin at 60°F. Few flies survive exposure to temp. of 20°F. % dropped flies making normal recovery rises from approximately 1% to 20°F to 90% at 32°F.

Abupt and sudden temperature changes usually fatal to a high percentage of adults.

Inactive at night and under heavy clouds

Activity retarded by winds of 5-6 mph and preverted at 15 mph.

Inactive during continuous rainy periods

Daily ranges of as much as 40-50°F. markedly shortens the life of adults.

Lowest temp. at which oviposition occured was 65°F.

Maximum number successful matings on 3 day old flies oviposition maximum 5 days.

Fly population decreases when monthly mean temp. is less than 60°F.

Generally emerge in the morning (4-7 a.m.)

Rainfall tolerance - 0.4" per month

Larvae

Stage averages 6 days. Can endure up to 10 days at any temperature not fatal to host.

Body (host) must be alive til 2nd instar stage. Period lasted 36 to 96 hrs. at 86° - 52.4°F.

Surface temp. critical

a. Killed it, too hot

b. Larvae dropping at not less than 40°F immobile (soil temperature) Between 15° - 20°F they die.

Most larvae leave wound between 9 a.m. and 2 p.m. cooler the temp., the deeper they penetrate soil.

Prepaupae (0-48 hrs after leave wound) (desication critical)

Varies from 7-76 hours depending on environment.

When frozen at 13° to 23°F alk the prepupae died.

The heavier the soil, the deeper they go

7.77 inches in clay
2.48 inches in blacksoil
2.25 inches in sand
1.87 inches in gravel

R Feldch Jan 31, '73

10/10/1944

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UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
VETERINARY SERVICES
FEDERAL CENTER BUILDING
HYATTSVILLE, MARYLAND 20782

FEB 2 1973

January 26, 1973

Subject: Program Review and Evaluation on Screwworms

To: A. W. Cooper
Acting Deputy Administrator
ARS - Southern Region

We are having a program review and evaluation on screwworms at 9 a.m. on February 8, 1973, in Dr. E. E. Saulmon's office, South Building, Room 324-E, Washington, D.C.

The object of the conference is to review both past progress and our future plans for the screwworm program.

We would appreciate having entomologists from Agricultural Research Service participate. We especially request that Dr. E. F. Knipling, Dr. R. C. Bushland, and Mr. A. H. Baumhover attend.

Donald Miller

Donald Miller
Director
Programs Development and Application

cc:

✓ Mr. E. A. Taylor, ARS, Weslaco, Texas
Mr. A. H. Baumhover, ARS, Oxford, North Carolina
Dr. R. C. Bushland, ARS, Mission, Texas
Dr. M. E. Meadows, APHIS-VIC, Mission, Texas
Dr. L. Henderson, ARS, Beltsville, Maryland
Dr. J. L. Wilbur, APHIS-VS, Hyattsville, Maryland
Dr. H. C. King, APHIS-VS, Hyattsville, Maryland
Dr. N. L. Meyer, APHIS-EP, Hyattsville, Maryland

Geo. Burns, A.D.?

*2/2/73
Dr. Cooper's office
called and informed
that Dr. R.C. Bushland
plans to attend.
Guarantee*

FEB 2 1973

UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
VETERINARY SERVICES
FEDERAL CENTER BUILDING
HYATTSVILLE, MARYLAND 20854

Handwritten signature

cc:
Mr. E. A. Taylor, ARS, Weslaco, Texas
Mr. A. H. Baumhoyer, ARS, Oxford, North Carolina
Dr. R. C. Bushland, ARS, Mission, Texas
Dr. M. E. Meadows, APHIS-VIC, Mission, Texas
Dr. L. Henderson, ARS, Beltsville, Maryland
Dr. J. L. Wilbur, APHIS-VS, Hyattsville, Maryland
Dr. H. C. King, APHIS-VS, Hyattsville, Maryland
Dr. N. L. Meyer, APHIS-KP, Hyattsville, Maryland

U.S. DEPARTMENT OF AGRICULTURE

DATE

REFERENCE SLIP

2/2/73

TO

A. W. Cooper

☐ ACTION☐ NOTE AND RETURN☐ APPROVAL☐ PER PHONE CALL☐ AS REQUESTED☐ RECOMMENDATION☐ FOR COMMENT☐ REPLY FOR SIGNATURE OF☐ FOR INFORMATION☐ RETURNED☐ INITIALS☐ SEE ME☐ NOTE AND FILE☐ YOUR SIGNATURE

REMARKS Attached letter received
in our office today. Message
in letter relayed to your
office by phone.

Dr. R. C. Bushland plans
to attend this conference.

E. A. Taylor

FROM E. A. Taylor, AD
Weslaco, Texas

GPO : 1964 OF-742-069

FORM AD-514 (8-64)

Original letter to A. W. Cooper from
Donald Miller received here and
forwarded to Dr. Cooper 2/2/73.

Quawite

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AGI
FEB 1 1973

E. E. Taylor

UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE

VETERINARY SERVICES
SCREWORM ERADICATION PROGRAM
POST OFFICE BOX 969
MISSION, TEXAS 78572

January 29, 1973

Subject: Transportation of Personnel
Between Mission and Tampico

To: Dr. R. C. Bushland
Acting Location Leader
Screwworm Research Lab
Mission, Texas

As we discussed this day, we are cooperating in every way possible in trying to arrange air transportation for your personnel operating out of Tampico, Mexico. This transportation being between Mission and Tampico. Since the number of passengers that can travel on each given flight is limited, it is thought best that all arrangements for this travel be made through one central location. In addition to your personnel traveling on these flights between Mission and Tampico there will also be personnel from our organization including those from the Methods Development Section who will be working jointly with your people and maintenance personnel with responsibilities at the Tampico Distribution Center as well as personnel from Field Operations connected with the operation of the distribution center at Tampico.

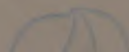
It is anticipated that requests for travel to and from Tampico will exceed the space available on the aircraft and priorities will need to be established. Dr. Meadows and/or myself will make the decisions as to who will be able to accompany any given flight when there are requests for more people to travel than there are seats available on the aircraft based on these priorities.

All requests for travel aboard program aircraft should be given to either Mrs. Betty Liebe or Mrs. Lynda Pigg at Exts. 33, 36, or 41. These requests should be given as far in advance of the expected travel as possible. Mrs. Liebe or Mrs. Pigg will contact the appropriate people concerning this travel when requested and will then notify those who have made such requests whether space is available on the desired day of travel or whether other arrangements need to be made.

James E. Novy

James E. Novy
Acting Veterinarian in Charge
Animal Health

cc:
Dr. M. E. Meadows, Jr.



UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
Screwworm Research Laboratory
P. O. Box 986
Mission, Texas 78572

JAN 31 1973

January 30, 1973

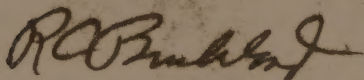
Subject: Request for Travel Authorization

To: E. A. Taylor, Area Director
USDA, ARS, Southern Region
Weslaco, Texas 78596

Last week Dr. Williams told me that Dr. Saulmon, Deputy Administrator, APHIS, had called a screwworm conference in his office, to be held on February 8. He said that Dr. Knipling had agreed to attend and that APHIS was requesting from Dr. Cooper permission for Mr. Baumhover of the Oxford, N. C., laboratory, and me from Mission, ARS, to participate.

It is my understanding of TC 72-116, 12/29/72, that I do not have the authority to issue a TR. On that basis, I am enclosing for your signature a TR for transportation from McAllen to Washington, D. C. and return, if my travel is approved.

I propose to fly up on February 6 in order to have private discussions on February 7 to be better prepared for the formal meeting on February 8. I have made return reservations for February 9.



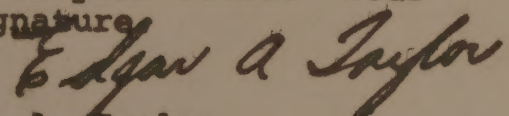
R. C. Bushland
Research Leader

Enclosure
TR #B-2,306,098

ENDORSEMENT:

Jan. 31, 1973

The above is considered a work conference in connection with your research and does not require formal approval. You can sign your own TRs and those of your staff. Your TR is herewith returned for your signature.


E. A. Taylor

UNITED STATES DEPARTMENT OF AGRICULTURE

AGRICULTURAL MECHANICS SERVICE

WASHINGTON, D. C. 20250

U. S. 500 500

Washington, D. C. 20250

January 30, 1971

Subject: Request for Travel Authorization

Mr. E. A. Taylor, Area Director
USDA, 400, South Main Street
Waco, Texas 76798

Last week Mr. Williams told me that Mr. Taylor, Deputy Administrator, ARS, had called a conference in his office. He said that Mr. Williams had agreed to accept the position of Deputy Administrator for Mr. Taylor's office. Mr. Williams, U. S. Laboratory, and Mr. Williams, ARS, in person.

It is my understanding that Mr. Williams, ARS, is not going to be transferred to ARS. He is still in his office. I am assuming that Mr. Williams is still in his office. I am assuming that Mr. Williams is still in his office.

I assume that Mr. Williams is still in his office. I am assuming that Mr. Williams is still in his office. I am assuming that Mr. Williams is still in his office.

[Handwritten signature]

E. A. Taylor
Deputy Director

Enclosure
U. S. 500 500

Jan. 31, 1971

ENCLOSURE

The above is enclosed a work conference in connection with your research and does not require formal approval. You can also find the same in your file. Your

[Handwritten signature]
E. A. Taylor

UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
WASHINGTON, D. C. 20250

FEB 2 1973

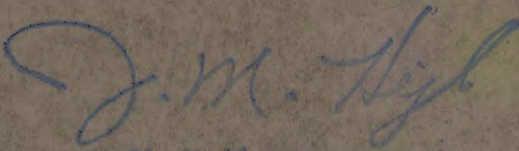
JAN 30 1973

Subject: Technical Conference on Screwworm Program

To: A. W. Cooper
Acting Deputy Administrator
ARS - Southern Region

We are having a Technical Conference at Mission, Texas, on the screwworm program at 9 a.m. on February 28, 1973.

We appreciate having you and other members of your organization participate in this Conference. Discussions will cover both short and long range plans for the screwworm program. We would particularly like to have Dr. R. C. Bushland and his group attend as well as Mr. A. Baumhover, Research Leader.


J. M. Hall
Acting Deputy Administrator
Veterinary Services

cc:

✓ Mr. E. A. Taylor, ARS, Weslaco, Texas
Mr. A. Baumhover, ARS, Oxford, North Carolina
Dr. R. C. Bushland, ARS, Mission, Texas
Dr. M. E. Meadows, APHIS-VIC, Mission, Texas
Dr. L. Henderson, ARS, Beltsville, Maryland
Dr. J. L. Wilbur, APHIS-VS, Hyattsville, Maryland
Dr. N. L. Meyer, APHIS-EP, Hyattsville, Maryland

FEB 2 1973

UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
WASHINGTON, D. C. 20250

JAN 20 1973

Subject: Technical Conference on Sereneworm Program

To: A. W. Cooper
Acting Deputy Administrator
ARS - Southern Region

We are having a Technical Conference at Mission, Texas, on the sereneworm program at 9 a.m. on February 28, 1973.

We appreciate having you and other members of your organization participate in this Conference. Discussions will cover both short and long range plans for the sereneworm program. We would particularly like to have Dr. R. C. Bushland and his group attend as well as Mr. A. Baumhoyer, Research Leader.

J. M. Taylor
Acting Deputy Administrator
Veterinary Services

cc:
Mr. E. A. Taylor, ARS, Weslaco, Texas
Mr. A. Baumhoyer, ARS, Oxford, North Carolina
Dr. R. C. Bushland, ARS, Mission, Texas
Dr. M. E. Meadows, APHIS-VIC, Mission, Texas
Dr. L. Henderson, ARS, Beltsville, Maryland
Dr. J. L. Wilbur, APHIS-VS, Hyattsville, Maryland
Dr. N. L. Meyer, APHIS-ER, Hyattsville, Maryland

FEB 8 1973

Screwworm Research Laboratory
P. O. Box 986
Mission, Texas 78572

February 6, 1973

Subject: Mr. D. E. Hopkins, Entomologist, Kerrville, Texas,
Services on Field Work on Screwworms in Puerto Rico
and Vieques

To: Dr. J. L. Hourrigan
Senior Staff Veterinarian
Sheep, Goat, Equine, and Ectoparasites
Hyattsville, Maryland

Upon receipt of your memorandum of January 26, I telephoned Dr. Drummond at Kerrville. He informed me that you had sent a copy of your memorandum to Mr. Hopkins and that they had already discussed your request for Mr. Hopkins' services. Mr. Hopkins is pleased to go.

Dr. Drummond said that the Kerrville Laboratory would be glad to furnish Mr. Hopkins' services for the month of March if APHIS could handle the travel expenses.

Mr. Hopkins had been loaned to the Mission Laboratory for the period August through February so it was necessary that I check with Dr. Drummond who controls the activities of Mr. Hopkins' permanent station.

I am indeed pleased that Mr. Hopkins and Dr. Drummond are eager to continue the cooperation. I suggested to Dr. Drummond that Mr. Hopkins come to Mission on the afternoon of February 27 so that he can attend the screwworm conference on February 28 and be instructed by you and your associates regarding his Puerto Rican assignment.

R. C. Bushland
Research Leader

cc: D. L. Williams
R. O. Drummond
X. A. Taylor
D. E. Hopkins

FEB 8 1973

MEMORANDUM FOR THE DIRECTOR

SUBJECT: [Illegible]

1. [Illegible]

2. [Illegible]

3. [Illegible]

4. [Illegible]

5. [Illegible]

6. [Illegible]

7. [Illegible]

Very truly yours,
[Illegible Signature]
[Illegible Title]

Mr. E. A. Taylor, Area Director
USDA, ARS, Southern Region
509 W. Fourth
Weslaco, Texas 78596

Mr. E. A. Taylor, Area Director
U.S. Forest Service, Southern Region
500 W. Fourth

FEB 13 1973

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE

SOUTHERN REGION
701 LOYOLA AVENUE
P. O. BOX 53326
NEW ORLEANS, LOUISIANA 70153

EDJ

February 8, 1973

Subject: Technical Conference on Screwworm Program

To: J. M Hejl, Acting Deputy Administrator,
Veterinary Services, APHIS
Washington, D. C.

This is in response to your January 30 memorandum to Dr. A. W. Cooper regarding the above subject. We will be pleased to have Dr. R. C. Bushland and members of his staff, as well as Mr. A. H. Baumhover, attend the technical conference at Mission on February 28. In addition, Mr. E. A. Taylor, Director of our Sub-Tropical Texas Area will also probably be present. Unfortunately, previous commitments will prevent either Dr. Cooper or me from attending.

H C Cox

H C Cox
Acting Deputy Administrator

cc:

✓ E. A. Taylor, Weslaco, Texas
G. R. Burns, Raleigh, N. C.
R. C. Bushland, Mission, Texas
A. H. Baumhover, Oxford, N. C.

Bushland
ET

FEB 27 1973

Beltsville, Maryland 20705

February 22, 1973

Subject: Request for Assistance on Screwworm Nutrition

To: W. M. Bruce, Area Director, Tifton, Georgia

Two weeks ago APHIS and ARS scientists met in Washington, D. C., to review the screwworm program. As you know after 9 trouble-free years the program was a disappointment in the last season. Losses to the cattle industry were about \$40 million in 1972.

Although corrective actions have been taken, there is strong evidence that the released sterile males are performing poorly. Drs. E. F. Knipling and R. C. Bushland believe that the artificial diet is nutritionally inadequate. They strongly recommended that Dr. Ray F. Moore, Florence, South Carolina, spend a number of days at the mass rearing facility at McAllen and attempt to analyze the difficulty.

I spoke to Dr. H C Cox by telephone, and he suggested that I clear this matter with you. In addition Dr. Cox stated that he is willing to discuss practical problems in sending Dr. Moore to McAllen with you.

If Dr. Moore can make a contribution, it should be made in advance of the next fly season.

Waldemar Klassen

Waldemar Klassen
Staff Scientist
Pest Management

cc:

L. S. Henderson
E. A. Taylor ✓

physcy to Dr. Bushland
3/14/73. J. J. J.

FEB 27 1973

Beltsville, Maryland 20705

February 22, 1973

Subject: Request for Assistance on Screwworm Nutrition

To: J. Rex Johnston, Area Director, College Station, Texas

Two weeks ago APRIS and ARS scientists met in Washington, D. C., to review the screwworm program. As you know, after 2 trouble-free years the program was a disappointment in the last season. Losses to the cattle industry were about \$40 million in 1972.

Although corrective actions have been taken, there is strong evidence that the released sterile males are performing poorly. Drs. E. F. Knippling and R. C. Bushland believe that the artificial diet is nutritionally inadequate. They strongly recommend that Dr. R. Gingrich, Kerrville, Texas, spend a number of days at the mass rearing facility at McAllen and attempt to analyze the difficulty.

I spoke to Dr. H. C. Cox by telephone, and he suggested that I clear this matter with you. In addition Dr. Cox stated that he is willing to discuss with you practical problems in sending Dr. Gingrich to McAllen.

If Dr. Gingrich can make a contribution, it should be made in advance of the next fly season.

Waldemar Klassen
Staff Scientist
Pest Management

cc:
L. S. Henderson
E. A. Taylor

Copy to Dr. Bushland
2/24/73 J. Johnston

REFERENCE SLIP

3/19/73

TO

R. C. Bushland

☐ ACTION☐ NOTE AND RETURN☐ APPROVAL☐ PER PHONE CALL☐ AS REQUESTED☐ RECOMMENDATION☐ FOR COMMENT☐ REPLY FOR SIGNATURE OF☒ FOR INFORMATION☐ RETURNED☐ INITIALS☐ SEE ME☐ NOTE AND FILE☐ YOUR SIGNATURE

REMARKS

FROM

Edgar A Taylor

1871
Jan 10
1871

MAR 11 1973
Wesley

Copy to Bushman
MAR 9 1973
JH
EAB

March 6, 1973

SUBJECT: Screwworm Nutrition

TO: Dr. J. Rex Johnston, Acting Area Director
ARS, USDA, Oklahoma-Texas Area, Southern Region
Bushland, Texas 79012

THROUGH: Dr. R. O. Drummond

As you know from the memorandum of February 26 from Dr. Waldemar Klassen, I have been asked to review the present problem with the performance of screwworm flies in the eradication program. I have cooperated in the past with the personnel at the rearing plant in Mission on nutritional problems and would be pleased to do so again.

When consulted before on screwworm problems, I encountered situations similar to the present one. Namely, there is doubt about the performance in the field of laboratory reared flies. Among the many possible causes for the poor performance it has been suggested that the flies had low vitality - a condition possibly related to their diet and other rearing procedures. Also, as before, there still seems to be difficulty in delineating the problem. Without this ability you cannot assign the problem to nutritional factors. If you assume this is the fault you still lack the specific goals needed for experimentation and methods for the field evaluation of your results.

Previously I was consulted when it was decided that the problem was the inferior size of artificially reared flies. Our goal of rearing larger flies was achieved but there was no way to determine if this was in fact the solution. Later, after further difficulties with eradication efforts occurred, it was suggested by some that maybe our flies were too big--perhaps they were just big and lazy but at least there was no way to test to settle the question one way or another.

I see the same problems with the present situation. Poor longevity of the presently used (old) strain is mentioned, but since the new strain is living longer on apparently the same diet I don't think nutritional factors are to blame. This is possibly a genetic difference. Robustness was also mentioned, but again this is a nebulous goal and one that will need testing in the field.

MAR 14 1973
Wheeler

March 9, 1973

SUBJECT: Screwworm Nutrition

TO: Dr. J. Rex Johnston, Acting Area Director
ARS, USDA, Oklahoma-Texas Area, Southern Region
Bushland, Texas 79012

THROUGH: Dr. R. O. Drummond

As you know from the memorandum of February 28 from Dr. William H. Hester, I have been asked to review the present problem with the nutrition of screwworm flies in the eradication program. I have consulted in the past with the personnel at the existing plant in Houston and nutritional problems and would be pleased to do so again.

When consulted before on screwworm problems, I encountered a few known similar to the present one. Namely, there is some doubt about the performance of laboratory reared flies. Among the many possible causes for the poor performance it has been suggested that the flies had low vitamin levels, diet possibly related to their diet and other feeding or husbandry. Also, as before, there still seems to be difficulty in obtaining the flies. Without this ability you cannot reach the problem of nutritional deficiency. If you assume this is the fault you still have the specific problem for experimentation and methods for the flies with the low vitamin levels.

Previously I was consulted when it was decided that the problem was the inferior state of artificially reared flies. The goal of feeding program was achieved but there was a need to determine if this was the cause. Later, after further investigation with experimental animals occurred, it was suggested by some that perhaps the flies were just big and heavy and that the problem was not a nutritional one. To settle the question one way or another.

I see the need for flies which are present in the program. I am not sure if the flies are good (old) when the material is used. Since the new strain is being brought in regularly, we should have a good supply of flies. This is possibly a genetic difference. I have seen some flies which are not good and one that will feed feeding in the field.

March 6, 1973
Dr. J. Rex Johnston
Page 2

I think the suggestion of Dr. Klassen that comparative chemical analyses of wound-reared and artificially reared screwworms is sound and would possibly provide valuable background data, although I am not convinced that rearing an insect with a similar chemical composition to a wound-reared individual would insure the proper performance of the product. There is much data available on insect nutrition that can be applied now to manipulate and alter the final screwworm product, but the basic problem remains - what characteristics in a fly do you aim for and how do you field test to determine if this characteristic enables the fly to do the job you want.

I have not been closely associated with the screwworm eradication program the past 2 years and I have not been informed of recent developments. If the problems I mentioned above no longer exist then I believe there are immediate positive goals that can be achieved through further nutritional studies. In any case, I am willing to lend whatever assistance I can in further cooperation with the program.

Richard E. Gingrich
Research Entomologist

cc:

W. Klassen
R. F. Moore
E. A. Taylor ✓
W. M. Bruce

ARS:REGingrich:jf (3-6-73)

I think the suggestion of Dr. Klassen that comparative chemical analyses of wound-treated and artificially reared screwworms is sound and would possibly provide valuable background data, although I am not convinced that rearing an insect with a similar chemical composition to a wound-treated individual would insure the proper performance of the product. There is much data available on insect nutrition that can be applied now to manipulate and alter the final screwworm product, but the basic problem remains - what characteristics in a fly do you aim for and how do you field test to determine if this characteristic enables the fly to do the job you want.

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Richard E. Gingrich
Research Entomologist

cc:
W. Klassen
R. E. Moore
E. A. Taylor
W. M. Bruce

ASB:REG:agch:lf (3-6-73)

MAR 2 1973

Beltsville, Maryland 20705

February 26, 1973

Subject: Screwworm Nutrition

To: R. E. Gingrich, Kerrville, Texas
R. F. Moore, Florence, South Carolina

Recently a joint ARS-APHIS meeting was held in Washington, D. C., to review the screwworm suppression program. The feeling persists that released flies are performing very poorly in the field. Evidently most of the obvious corrective measures have been implemented. A new strain has been colonized but it is doubtful that it can be adapted for mass rearing in time for the next fly season.

Therefore there is a need to consider what can be done to improve the performance of the currently used release strain. The longevity of this strain appears to be less than that of the new strain or of the strain that was used in the Florida program.

Dr. Bushland and Dr. Knipling have informed me that screwworms reared on an artificial medium do not have the robust appearance of wound-reared individuals. Even if screwworms are prematurely removed from a wound and then allowed to develop into adults without additional nourishment, these adults appear to be robust, though small. Therefore the various artificial diets (currently nutria meat, etc.) do not provide some factor(s) that is present in the living host. As you know the screwworm is an obligate parasite and presumably it has some nonessential nutritional needs that are not provided by meat. In this respect the screwworm differs from the secondary screwworm and other Calliphoridae.

As you know fetal calf serum is needed to grow many strains of insect cells. I believe that Dr. E. P. Marks, MRRL, was able to replace fetal calf serum with a solubilized form of cholesterol, etc. Perhaps the simplest and most direct approach to identify nutritional needs would be to analyze wound-reared screwworms and compare the analysis to that for artificially reared individuals.

The purpose of this memorandum is to request that you review this problem and work with your Area Director to determine what you may do to resolve it.

Waldemar Klassen

Waldemar Klassen
Staff Scientist
Pest Management

cc:
J. Rex Johnston
E. A. Taylor ✓
W. H. Bruce

MAR 2 1973

February 1973

February 1973

Subject: [illegible]

To: [illegible]

From: [illegible]

[illegible text block]

[illegible text block]

[illegible text block]

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[illegible text block]

[illegible signature]

[illegible text block]

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UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
SOUTHERN REGION
701 LOYOLA AVENUE
P. O. BOX 53326
NEW ORLEANS, LOUISIANA 70153

E. A. Taylor
Weslaco, Tex
MAR 15 1973

March 12, 1973

Subject: Assistance on Screwworm Nutrition Research

To: The Record

Subsequent to a recommendation by Dr. Waldemar Klassen that Drs. R. F. Moore and Richard Gingrich visit Mission to see if they could provide assistance on a problem in screwworm rearing which is apparently associated with nutrition, I talked by telephone with Mr. Bruce, Dr. Bushland, and Dr. Moore. Mr. Bruce was concerned that Dr. Bushland might not be aware of the proposed visit by Drs. Moore and Gingrich. However, Dr. Bushland assured me that he would welcome their aid. I asked Dr. Moore to contact Dr. Bushland and work out an appropriate time when he and Dr. Gingrich could visit the Mission Laboratory. Dr. Moore expressed concern about a lack of travel funds, particularly since the trip would be in support of a project other than his own. I asked Dr. Moore to perform the travel and send us a voucher or some statement of costs incurred, assuring him that he would be reimbursed for funds expended.

H C Cox
H C Cox
Associate Deputy Administrator

cc:

N. S. Bridges
J. R. Johnston, Bushland, Tex.
W. M. Bruce, Tifton, Ga.
R. O. Drummond, Kerrville, Tex.
H. M. Taft, Florence, S. C.
W. Klassen, NPS, Beltsville, Md.
R. C. Bushland, Mission, Texas
✓ E. A. Taylor, Weslaco, Texas



Dr. Bushland
Mr. Taylor
13 MAR 1973

UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE

VETERINARY SERVICES

SCREWORM ERADICATION PROGRAM

POST OFFICE BOX 969

MISSION, TEXAS 78572

March 13, 1973

Subject: Justification for Increase in Fly
Colony Space

To: Dr. J. L. Wilbur
Regional Director - Western
Hyattsville, Maryland

I have been requested by the staff to technically back up our request for increasing the fly colony. I did not do this in my original letter because I felt the subject was well discussed in the Technical Meeting and that you were well aware of the reasons.

Every precaution should be taken to assure ourselves that we do not have another year like the one we just finished. We do know that the new Texas strain (ARS) lives twice as long as our present strain. There appears to be a relationship between how rapidly our plant strain can egg and its total longevity. Therefore, on the new Texas strain we need to egg as late as possible in an attempt to retain these longevity characteristics and other wild characteristics which we think will contribute to the quality of our flies. We do know that we need more fly colony space at full production even with the strain we now have because many days we do not have ample eggs to meet our requirements for this production level. To me, these reasons are ample for requesting that the fly colony size be increased.

I asked Dr. Bushland to prepare a statement for me on this subject, and it is attached. Also enclosed is a Xerox copy of a paper by E. Boller, Behavioral Aspects of Mass-Rearing of Insects, which has caused Dr. Bushland much concern in the past few days. I hope this information satisfies the needs of the staff.

At the present time, I am not convinced that our present strain is not performing in a satisfactory manner in the field. We have not had a case collected in Texas since February 20. The number of cases being confirmed in northeastern Mexico is also

Statement from Dr. R. C. Bushland

March 13, 1973

During the period February 15 to March 8, our Methods Development-Entomology Research team at Tampico collected 25 egg masses from trap animals. 15 hatched and only 10 were sterile. This sample is too small to be highly significant but it is disappointing that only 40 percent of the sample received sterile matings.

Data obtained by Dr. Crystal in the Entomology Research Laboratory where the flies are maintained under the best possible research conditions with the 12 hour day, 12 hour night, ample food and water, and in uncrowded cages, show that the male flies of the present strain live an average of 11 days and the females live 15 days. (This is a better record than we can get under routine quality control conditions.)

In comparative tests with the new strain of flies, Dr. Crystal shows that the average male of the new strain lives 20 days and the average female 21 days. When you figure that a male is three days old before he can mate and subtract this figure from Dr. Crystal's values, you get an average mating life of 8 days for the presently released strain and 17 days for the new strain. Hence, one would expect twice the mating competitiveness in the field from the new strain.

In domesticating flies to cage life, they go through a bottleneck of selection in which those most suited to laboratory life survive and increase. These conditions may not be favorable to survival in the field.

To amplify the scientific data associated with this, I suggest that you read the attached Xerox copy of Behavioral Aspects of Mass-Rearing of Insects by E. Boller.

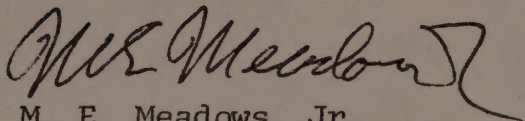
On the basis of longevity alone of the sexually mature flies, the new strain should be twice as efficient as the one in current production. When you also consider the many intangibles associated with domestication of strains, it is important to release flies taken as recently as possible from the wild state.

(Your attention is particularly called to the curve on page 11 of the attached paper.)

very encouraging for this time of the year. The thing that alarms me is that if the situation in northeastern Mexico is not as good as the confirmed cases indicate, because of poor reporting, we could be in trouble and not realize it.

Dr. Bushland and his people in the Tampico area are very concerned because the 25 egg masses collected so far have all been collected by our people. None have been received from the Mexico force. Only 40 percent of these collections were sterile. Also, 17 of the 25 masses came from one ranch, which indicates that fertile flies are in the area. Yet the other ranches in the vicinity are not sending in samples. (Our test pens accounted for the other 8 samples.)

I realize that the people in the Mexico City office are busy working on the Mexico Program, but I do not think they should lose sight of the importance of reporting for the next few weeks. To assure that we know precisely what the situation is, I feel as many people as possible should be out in the field down there.



M. E. Meadows, Jr.
Veterinarian in Charge
Animal Health

2 Enclosures
a/s

very interesting. The idea of the book, the thing that
interests me is that it is the situation in connection with it
and not the situation in connection with it. I am not
satisfied, we could be in trouble and not realize it.

Dr. Henshaw and his people in the region are very
interested in the people. They have been working for the
people. Only 50 percent of the population was
able to get the 50 percent of the people, which
is not the case in the area. The other people in
the country are not working in the area. (The
country is the other 50 percent.)

I realize that the people in the region are busy
working on the land. I do not think they should
lose sight of the importance of working for the
people. To ensure that we have people in the
area, we must be in the field with them.

W. E. Henshaw, Jr.
Veterinarian in Charge
Animal Health

2 Enclosures
W/E

Eut

April 6, 1973

Subject: Screwworm Nutrition

To: Dr. Waldemar Klassen
USDA- National Program Staff
Beltsville, Maryland 20705

Through: R. M. Taft, Research Leader
Southeastern Cotton Insects Investigations

I arrived in McAllen, Texas on March 29, 1973 and visited the Mission Rearing Facility the following day. In the morning, Mr. Frank Dudley, Bio-technician, Fly Production gave me a tour of the plant and an excellent explanation of the rearing process and of the problems in this program. In the afternoon I visited with Dr. M. H. Crystal, Research Entomologist, and Mr. G. W. Eddy, Research Entomologist, both of the Screwworm Research Laboratory and Dr. H. C. Hoffman, Research Entomologist, Methods Development. The weekend was spent in studying materials supplied by ARS and APHIS.

On Monday, Apr. 2, 1973, Dr. R. E. Gingrich from Kerrville, Texas and I discussed screwworm nutrition with Dr. H. C. Bushland. Later in the day we talked with Mr. A. J. Graham, Staff Entomologist.

These discussions produced the following objectives and proposed approach to achieve the objectives:

The primary objective is to develop a series of nutritional experiments that would have the potential of producing, from an artificial diet, a fly that resembles the wild fly more closely than those now reared on artificial media. Specifically, a fly which has the "blue" color and "broad" thorax of the wild fly. It was suggested that the "blue" color may have a value in mate selection in the wild and that the "broad" thorax might indicate a strong capacity for flight and hence a fly that is able to compete effectively for mates. It is also possible that these visible defects indicate that there are other invisible biochemical defects which reduce the competitiveness of the lab-reared fly.

A secondary objective is to evaluate and suggest sources of proteins that would be more economical than that currently in use but still produce a male fly that is competitive with the wild fly.

RECEIVED

APR 16 1973

AREA OFFICE
WESLACO, TEXAS

RECEIVED

ALBANY
NEW YORK

Objective 1

Screwworm flies produced on artificial diets have been found to have a more narrow thorax and to be more green in color than those reared in the wound of a living animal. Diets containing meat should be most comparable to the natural diet. Therefore, it is suggested that efforts be made to obtain a wild type of adult fly by modification of a meat diet.

There are 4 areas where modifications could be made that might result in the desired type of fly. These, in suggested order of importance, are: (1) nutrition, (2) minerals, (3) vitamins, and (4) microbial inhibitors. Selection of the modifications to be made to the meat diet in nutrition requires the following information: A. Analysis of beef blood plasma, red cells, and muscle for total protein, amino acid content, mineral content, selected vitamins, cholesterol, and other components that might be suggested by a more complete search of the literature; B. Analyses of larvae and adults of wild screwworm flies for total protein and amino acids; C. Analysis of larvae and adults of lab-reared insects for total protein and amino acids; and D. Separation of proteins by electrophoresis from wild and lab flies might give useful information if differences are found.

It is requested that you determine if there is someone on the National Program Staff who will be able to locate the information required in A. Also, could you determine if the analyses required in B and C can be done at a laboratory of the Department of Agriculture? The information would be used to adjust the balance of essential amino acids and insure an adequate supply of those that might be growth limiting such as lysine and methionine.

Modifications in the minerals will be based on information in the literature; the objective is to insure that adequate trace elements are included in the media. Dilution and loss of some vitamins is almost certain, so it is suggested that a complete mixture be added. Microbial inhibitors would have the objective of preventing decay and bacterial contamination and the associated change in nutritional value of the diet. Their selection would be aided by results from the literature.

Design and testing of a device to produce a slow, constant flow of blood plasma over the larvae might be desirable if the above changes are not successful. Such a device would have the effect of constantly removing waste products and approximating the natural environment more closely.

Objective 2

The information on amino acids obtained for objective No. 1 and the published amino acid mixture of Dr. Gingrich will be useful in attaining this objective.

It is suggested that various sources of protein such as soybean, Child Food Supplement #2 (corn-soybean-milk), Wheat[®], and others be analyzed for total protein and amino acid content. These proteins might then be enriched with essential amino acids that are limiting and then be used as a more economical protein than is now available.

Miscellaneous

The liquid diet now uses linters cotton as a substrate for the screwworm larvae. The diet is changed by vacuuming off about one-half of the spent liquid and then fresh diet is added. This results in lost nutrients in the portion removed and the fresh diet is diluted with the wastes of the diet that was left. Recently, several companies have developed a process for putting soybean protein into a form that has the texture of meat. Use of this technique might make it possible to put the liquid diet into a semi-solid form and permit the larvae to move from the spent to fresh diet as now occurs in the diet based on meat.

It might be worthwhile to determine if the color of the adult screwworm is the result of pigments in the cuticle or the diffraction grating method of color formation. Electron microscope studies might determine this and could provide a clue to the difference in color between wild and lab-reared flies.

Action to be Taken

It is recognized that these objectives cannot be reached in time to be of value to the releases of flies scheduled for the 1973 season. More effective results are expected if required nutritional data are obtained and the literature reviewed and then the information used to design the diets to be tested. The goal is to receive this information by September 1973.

I would be willing to plan my research program at Florence, S. C. so that it would be possible for me to return to the Screwworm Research Lab at Mission, Texas during the fall of 1973 for a period of approximately one month to assist in the initiation of these experiments.

This has been discussed with Mr. A. J. Graham, Staff Entomologist, and Mr. Ed Corrigan, Entomologist in Charge of Methods Development. They have concurred in this approach and feel that it could be possible for portions of this work to be done in the Mass Rearing Plant. Dr. R. E. Gingrich has indicated that he will be available to assist.

Your comments and reactions to this proposal, either by letter or telephone will be appreciated.

R. F. Moore, Jr.
Research Entomologist

cc: H C Cox, R. C. Bushland, W. M. Bruce, A. J. Graham, Ed Corrigan,
J. Rex Johnston, E. A. Taylor, R. E. Gingrich

UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
WASHINGTON, D. C. 20250

Mr. E. A. Taylor

cat

3 MAY 1973

Mr. C. G. Scruggs, Vice President
Southwest Animal Health Research Foundation
2613 Vestavia Forest Place
Birmingham, Alabama 35216

Dear Mr. Scruggs:

The next Technical Screwworm Conference will be held at Mission, Texas, on June 7, 1973, at 9 a.m. We plan to cover technical phases of the present program, as well as to review progress which has been made toward the Mexican Screwworm Eradication Program. We hope that you and other representatives of the Foundation can attend.

Sincerely,

E. E. Saulmon
Deputy Administrator

cc:

Dr. R. J. Anderson, Marshall, Texas
Dr. R. C. Bushland, ARS, Mission, Texas
✓ Mr. E. A. Taylor, ARS, Weslaco, Texas
Dr. L. Henderson, ARS, Beltsville, Maryland
Mr. C. N. Husman, Kerrville, Texas
Dr. H. C. Cox, New Orleans, Louisiana
Dr. M. E. Meadows, APHIS-VS, Mission, Texas
Dr. J. L. Wilbur, APHIS-VS, Hyattsville, Md.
Dr. E. E. Saulmon, APHIS-OA, Washington, D.C.

RECEIVED

MAY 7 1973

AREA OFFICE
WESLACO, TEXAS

Dr. E. A. Taylor

Mr. E. F. Saulmon

RECEIVED

UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
WASHINGTON, D. C. 20260

MAY 1973

Mr. C. C. Hennings, Vice President
Southern Animal Health Research Foundation
1813 Vestavia Forest Place
Birmingham, Alabama 35212

Dear Mr. Hennings:

The next Technical Symposium Conference will be held at Mission,

Texas, on June 7, 1973, at 9 a.m. We plan to cover technical

phases of the research program, as well as to review progress

which has been made toward the National Research Foundation Program.

We hope that you and other representatives of the Foundation can

attend.

Sincerely,

E. F. Saulmon
Deputy Administrator

- Dr. E. F. Saulmon, APHIS-04, Washington, D.C.
- Dr. J. L. Wilbur, APHIS-VS, Hyattsville, Md.
- Dr. M. E. Mesdows, APHIS-VS, Mission, Texas
- Dr. H. C. Cox, New Orleans, Louisiana
- Mr. C. N. Hansen, Kerrville, Texas
- Dr. L. Henderson, ARS, Beltsville, Maryland
- Mr. E. A. Taylor, ARS, Weslaco, Texas
- Dr. R. C. Bushland, ARS, Mission, Texas
- Dr. E. J. Anderson, Marshall, Texas

RECEIVED

MAY 7 1973
AREA OFFICE
WESLACO, TEXAS

Dr. E. F. Saulmon

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
~~ENTOMOLOGICAL RESEARCH DIVISION~~
PEE DEE EXPERIMENT STATION
P. O. BOX 271
FLORENCE, SOUTH CAROLINA 29501

June 6, 1973

E A Taylor
June 6/12
For information
03

Subject: Amino Acid Analyses of Screwworms

To: R. C. Bushland, Mission, Texas

Through: H. M. Taft, Research Leader
SE Cotton Insects Investigations

This is to confirm our telephone conversation of June 4 concerning the analysis of larval and adult screwworms for total protein and amino acids. A copy of a letter from Dr. R. J. Dimler, AD, concerning this subject is enclosed.

I talked with Mr. James Cavins by telephone and he indicated that he could schedule the analyses of amino acids in samples of screwworms. Mr. Cavins feels that 1 gm (dry weight) of a pooled sample of screwworms will permit duplicate analyses of amino acids and should be representative. It is preferred that the samples be freeze-dried before sending to Mr. Cavins. Frozen samples may be sent and Mr. Cavins will freeze-dry if it is not possible to freeze dry at the Screwworm Research Lab. Freeze-drying before shipment avoids the possible loss of sample due to accidental thawing while in transit.

I believe the routine analyses for 18-20 amino acids should be adequate for our purposes. As we agreed, the samples to be analyzed are:

1. Larvae, 48 hrs old, from laboratory medium
2. Mature larvae, 8-12 hrs after they leave the diet
3. Sheep-reared larvae, 8-12 hrs after they leave the animal
4. Lab-reared female flies, 36-48 hrs after emergence as adults
5. Lab-reared male flies, 36-48 hrs after emergence as adults
6. Sheep-reared female flies, 36-48 hrs after emergence as adults
7. Sheep-reared male flies, 36-48 hrs after emergence as adults

We agreed that you would contact Mr. James Cavins at Northern Regional Research Center, Cereal Properties Laboratory, Peoria, Illinois 61604 concerning the time when the flies would be shipped. Mr. Cavins' telephone number is FTS 309/685-4382.

Reg
R. F. Moore, Jr.

cc:

W. M. Bruce
J. Cavins
A. W. Cooper
R. J. Dimler
W. Klassen

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
NORTHERN REGIONAL RESEARCH LABORATORY
PEORIA, ILLINOIS 61604

11 JUN 1973

May 30, 1973

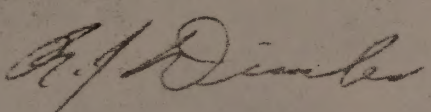
Subject: Amino Acid Analysis of Screwworms

To: R. F. Moore, Jr., Research Entomologist
Pee Dee Experiment Station
P.O. Box 271
Florence, South Carolina 29501

Through: H. M. Taft, Research Leader
Southeastern Cotton Insects Investigations

Mr. James F. Cavins of our Cereal Properties Laboratory has the analytical capabilities to analyze the six different screwworm samples for amino acid composition. Routine amino acid analyses of protein samples (18-20 amino acids) can be done at a rate of 3 or 4/day/SMY. More extensive physiological fluid analyses (40-50 amino acids) would require 1 week/SMY for setup and 1 sample/day/SMY. The sample can be frozen or freeze-dried and about 1 gram dry weight would be needed for either type of analysis.

You should contact Mr. Cavins by mail or telephone (FTS 309 - 685-4382) to make the necessary arrangements, including the number of amino acids to be measured and timing of the work.


R. J. Dimler
Area Director

cc:
F. R. Santi, NPS
E. R. Glover, NCRO
A. W. Coover, SRO
W. M. Bruce, AD

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE

WESTERN REGION
2850 TELEGRAPH AVENUE
BERKELEY, CALIFORNIA 94705

July 16, 1973

Graham
/ Bushland
Hart
Lime
McDonald
Heald
Menges
Wutscher
Thomas
Wiegand
Morgan

Reply to: USDA, ARS, Western Region
Statistical Laboratory
Colorado State University
Fort Collins, Colorado 80521

Subject: Visit to Subtropical Texas Area - June 25-30

To: Edgar A. Taylor
Area Director
USDA, ARS, Subtropical Texas Area
P.O. Box 267
Weslaco, Texas 78596

People Contacted

B.G. Hightower
Calvin Jones
Rolland Grabbe
E. Lopez
Wm. Allen
Harold Gausman
Craig Wiegand
Ross Leamer

RECEIVED
JUL 19 1973
AREA OFFICE
WESLACO, TEXAS

The largest percentage of the time was spent with the screw-worm project. Existing trap lines and some proposed trap sights were visited. Various aspects of the research were discussed.

I feel that the trip was very worthwhile to both ARS and myself. Appreciation and thanks are due Dr. Hightower for his time and effort in acquainting me with the projects.

Following are a few statistical comments that I would like to make:

Comparing traps

In going over the April experiment where a chemical attractant was compared with a standard liver attractant, a number of points became obvious which will make the data extremely difficult to analyze. First, the chemical was effective immediately and lasted 24 to 48 hours, while the liver did not become really effective until 72 hours. Some information can be obtained from this data but it is very difficult to make strong statistical comparisons because of the time effect involved. Secondly, the trap location is very important. After seeing the physical conditions and limitations involved, I have a better understanding of the problems.

It is essential that paired traps, if possible, be located in the same type of place. This does not always mean the same physical location, but the location should have the same potential for catching screw-worms. Evidently this was not the case with the April experiment. Many of the paired traps were not placed in similar 'potential catching' locations. Thirdly, the quality of flies released. In evaluating the percentage of fly caught from those released, it is worthwhile and essential to have an indication of the fly activity when they were loaded on the aircraft. This information may be available but our people could not give me any definite numbers. In talking with the research people involved with the April experiment, there had been some concern about the fly release of that period. I feel that in future experiments it is important to have an indication of the activities of the flies when they were loaded on the aircraft.

Weather Study

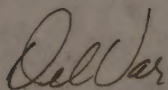
The new joint study with the US-Mexican governments on weather effecting screw-worm emergence is very interesting. It is important to select good locations for both the traps and weather station. I feel that the traps should be in a location where close control of released flies can be maintained.

There will be a lot of data coming from the weather station and fly traps. I was unable to obtain definite information on the relationship between weather station information and fly population. Is there any past information available for the screw-worm? I feel that it would be worthwhile to evaluate some of the old before we become inundated with new data.

Chemical Attractants

This is a very active area and good design is being carried out. However, it is difficult to statistically evaluate different organic compounds without isolating the pure compound first. Some specific statistical test to help with this evaluation was discussed with the research people involved.

Other research areas that were discussed and that need further statistical study are: the statistical evaluation of reported screw-worm cases; tests for evaluating the maintenance of wild characteristics in laboratory reared flies; designs for screw-worm diets studies; tests that could be used to evaluate fly emergence before release; statistical procedures for evaluating organic compounds released from animal wounds, and comparing methods for evaluating fly counts.



H. Del Var Petersen
Biometrician

cc: H.C. Cox
L.E. Myers
Gary V. Richardson

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H. Del Var Petersen
Biometrist

cc: H.C. Cox
L.E. Myers
Gary V. Richardson

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
SOUTHERN REGION
Screwworm Research Laboratory
P. O. Box 986
Mission, Texas 78572

July 25, 1973

Subject: Vision Studies of Four Strains of the Screwworm Fly

To: E. A. Taylor, Area Director
Subtropical Texas Area
Weslaco, Texas

Enclosed is a copy of a letter from Gerald Holt of the Fargo laboratory and a copy of my reply.

I thought that you and Dr. Cox would both be interested, not only in the test results, but also in the evidence of diligent support from the Metabolism and Radiation Research Laboratory. Considering the thoroughness of the study, I think that it is remarkable that Mr. Holt could gather all those data in two weeks' work. This study was arranged in informal telephone conversations with Fargo.

I was disappointed that the 18 Grandma (our ARS strain representing eggs collected last summer in Texas) flies could not see better than the other strains. This strain has since been crossed with flies representing six locations in Northern Mexico. This new strain is just now coming into mass production, and I hope will be good enough to replace the Texas (APHIS) strain now being used in the eradication program.

RC Bushland

R. C. Bushland
Research Leader

cc: H. C. Cox
G. G. Holt

Enclosure

*P. S. Would you please write Claude Schmidt
a note telling him of our appreciation
for this work. (I doubt whether he knows about it.)*
B

*summar
then over the phone. B*

Screwworm Research Laboratory
P. O. Box 986
Mission, Texas 78572

July 25, 1973

Subject: Vision Studies of Four Strains of the Screwworm Fly

To: Gerald G. Holt, Research Biologist
Insect Metabolism and Physiology Section
Metabolism and Radiation Research Laboratory
Fargo, North Dakota 58102

Thank you for your letter of July 5 transmitting data on the vision of the sterilized screwworms we sent you. I really do appreciate all the painstaking work you did.

I was disappointed that our ARS flies weren't superior. That strain was field-collected from 15 counties in Texas last May, and it was November before Dr. Crystal had all 18 blood lines combined by reciprocal crosses between males of one strain and females of another. This year he blended the genes of 6 collections of egg masses made during the past winter in Mexico and then crossed that 6 Grandma Mexican strain with the 18 Grandma ARS strain.

This new strain which the APHIS entomologists call Tex-Mex is just now coming into mass production in the APHIS plant. We hope to start field tests with it in another week.

Would you be willing to vision test this new strain in comparison with the APHIS and Florida strains? I suggest the Florida strain because it has been used for 10 years as a standard of comparison and the APHIS strain is the one we're trying to beat with a better fly.

If you can do the test, I'll send the pupae any time you say.

R. C. Bushland
Research Leader

cc Mr. Taylor ✓
Dr. Cox.

P.S. If I could go to Bushing (for the award) and then to Fargo we could plan physiological studies such as this and genetics work more efficiently than over the phone. B

Screwworm Research Laboratory
P. O. Box 986
Mission, Texas 78272

July 25, 1973

Subject: Vision Studies of Four Strains of the Screwworm Fly

To: Gerald G. Holt, Research Biologist
Insect Metabolism and Physiology Section
Metabolism and Radiation Research Laboratory
Fargo, North Dakota 58102

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If you can do the test, I'll send the pupae any time you say.

R. C. Bushland
Research Leader

CC Mr. Taylor
Dr. Holt

That's fine. I'd want to know if the crowd / and
then to know we could plan physiological studies
under this set of genetic work more effectively

10 JUL 1973

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
METABOLISM AND RADIATION RESEARCH LABORATORY
STATE UNIVERSITY STATION
FARGO, NORTH DAKOTA 58102

July 5, 1973

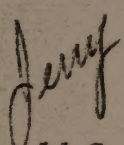
Subject: Vision Studies of Four Strains of the Screw-Worm Fly

To: R. C. Bushland
Screw-Worm Laboratory
Mission Texas

Here are the results of two weeks of testing eyes of the screw-worm. Based on the tests conducted, I can find no significant differences in the visual response parameters tested among the four strains. If you want a "scientific guess" as to how I would rate them, I would go with Texas (Aphis) and Puerto Rico. The 18 Grandma and the Florida strains would be a distant second choice. I cant pull the difference out individually by statistics but collectively, the 18 Grandma and the Florida strains look less responsive than the Texas (Aphis) and the Puerto Rico.

Please call me after July 30 if you have any questions. I'll be gone until then.

Best regards


Gerald G. Holt, Research Biologist
Insect Metqbolism and Physiology Section

encl. (as stated)

VISION STUDIES OF FOUR STRAINS OF THE SCREW-WORM FLY

Gerald G. Holt
July 5, 1973

List of Experiments

1. Spectral Efficiency (wavelength vs. response)
2. Sensitivity (intensity vs. response)
3. Resolving Power (critical fusion frequency)

Number Insects Tested

<u>Strain</u>	<u>No. Tested</u>
18 Grandma	10
Texas Aphis	10
Puerto Rico	5
Florida	5

Parameter of Measurement

The Electro Retinogram (ERG) can be described in three parts (see Fig. 2)

- a) the on response, which has its origin in the optic ganglia and may be used to measure the spectral effectiveness of the eye to varying wavelengths of light (i.e., amplitude in μ volts vs. wavelength).
- b) the negative plateau: origin is the visual cells of the eye.
- c) the off response, origin in the optic ganglia (also illustrates spectral sensitivity).

The overall height of the ERG may be used to measure the sensitivity of the eye.

Experiment I

Response vs. Wavelength:--The amplitude of the on response of the ERG is a measurement of spectral effectiveness. When compared with the blow fly, Calliphora, the spectral response is similar: There are two visible peaks -- one in the blue-green region and one in the red. There is also a peak in the UV, but we didn't look at UV sensitivity in these studies.

Conclusions:--Fig. 3 illustrates the spectral sensitivity of the four strains. It is similar to the blow fly, having a peak at 550 nm (blue-green) and one at 630 nm (red). Each point on the graph was analyzed statistically, and the results show no significant difference in the strains at the 5% level of confidence. See also Fig. 4 and 5, which show similar peaks for the negative plateau and the off response.

Experiment II

Response vs. Intensity:--In flies as illustrated by the Weber-Fechner law: over a short range, the height of the overall ERG is proportional to the log of the intensity. With this in mind, the following experiments were performed to compare the sensitivity of eyes from the four strains and to determine how much light (% T) was

required to cause a response of 300 μ volts amplitude. Linear regression was performed and the strains were compared.

Conclusions:--Table 6 shows the linear regression analysis of the total ERG response (-- μ volts vs. intensity (%T). Table 7 shows the linear illustrates the intensity of light required to evoke ERG response of 300 μ volts. Point by point statistical analyses show no among-strain differences at the 5% level of confidence. Tables 8, 9, 10 show the response of the on, neg. plat., and off response individually. Tables 8a, 9a, and 10a show these results on a bar graph, illustrating the intensity required to evoke a signal of a given amplitude. The negative plateau (i.e., the response of the visual cells) of the Florida strain are statistically lower than the other three strains. The significance of this is not known at this time (see Tables 9 and 9a).

Experiment III

Resolving Power of Eye:-- (The number of flashes/second the eye can distinguish as separate flashes). Critical fusion frequency was conducted on each eye tested. At the intensity used, the results are for comparative studies only. The Ferry-Porter law states that the critical flicher fusion frequency is proportional to the log of intensity, also the number of ommatidea stimulated. Thus, the higher light used the higher the FFF value.

Conclusions:--Table 11 illustrates the results of the flicker fusion study. They are as follows: 36 for 18 Grandma, 37.5 for Texas- Aphis, and 40.5 flashes/sec for both Puerto Rico and Florida strains.

Statistical analyses showed no difference at the 5% level of confidence among the strains.

SPECTRAL SENSITIVITY

ON TRANSIENT

TABLE NUMBER 3

SIGNAL (MICRO-VOLTS) AMPLITUDE SENSITIVITY

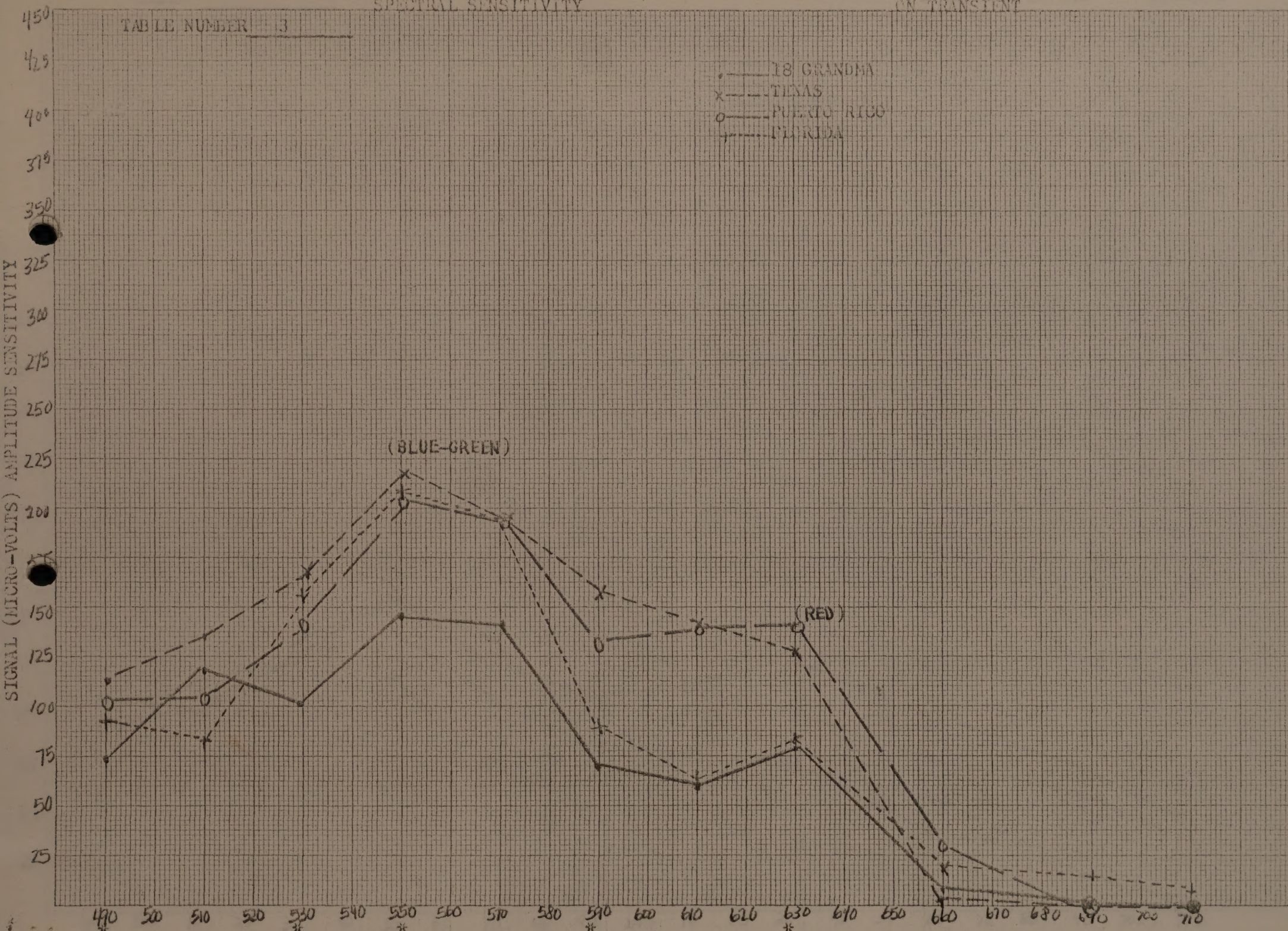
18 GRANDMA
X TEXAS
O PUERTO RICO
+ FLORIDA

(BLUE-GREEN)

(RED)

WAVELENGTH λ

K&E 10 X 1000 THE CENTIMETER 46 1510
MADE IN U.S.A.
KEUFFEL & ESSER CO.



SIGNAL (M VOLTS) AMPLITUDE SENSITIVITY

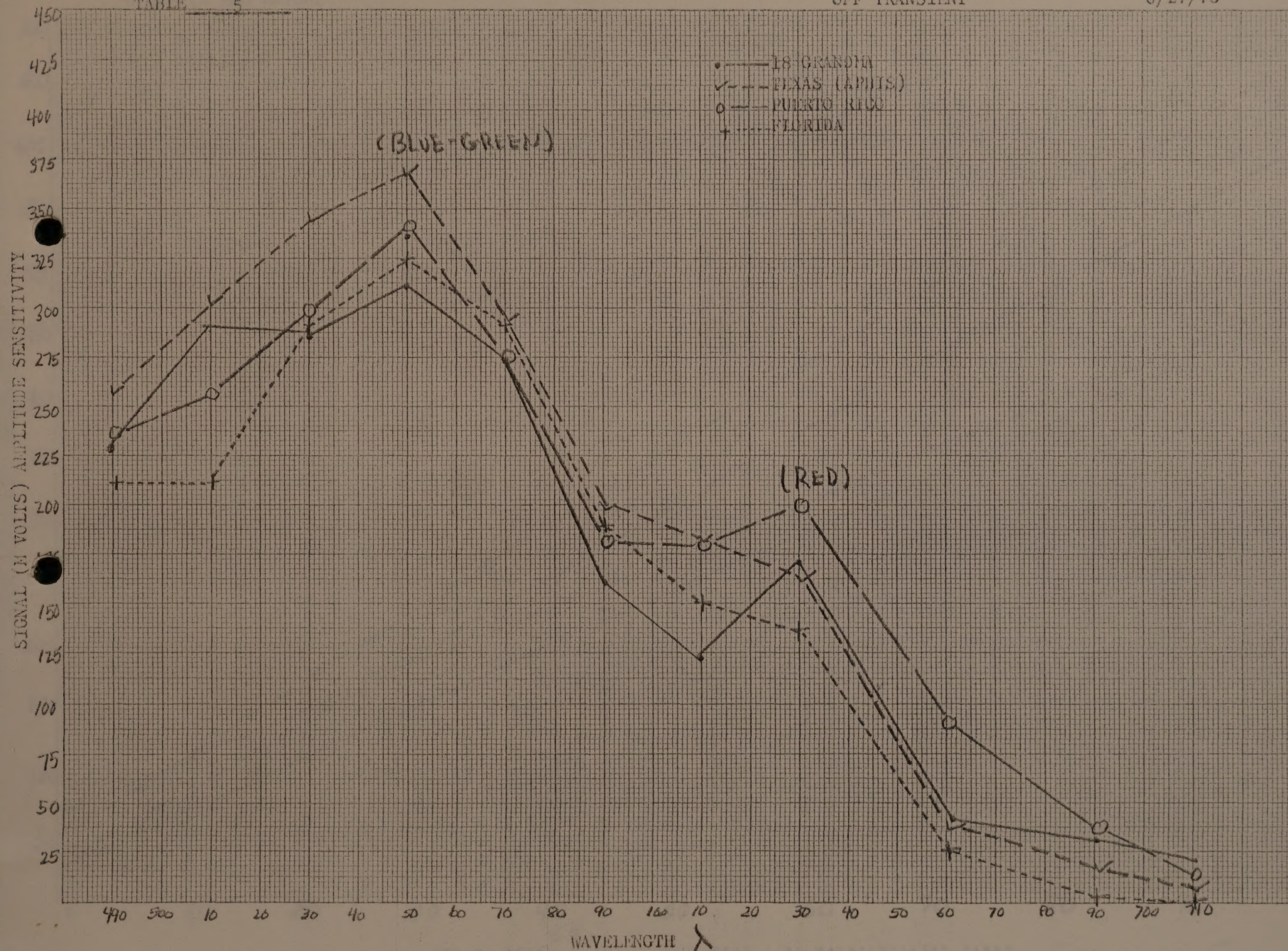
• — IS GRANDMA
 x — TEXAS (APHIS)
 o — PUERTO RICO
 + — FLORIDA

300
 275
 250
 225
 200
 175
 150
 125
 100
 75
 50
 25

490 500 10 20 30 40 50 60 70 80 90 600 10 20 30 40 50 60 70 80 40 50 60 70 80 90 700 710

WAVELENGTH λ

KE 10 X 10 TO THE CENTIMETER 46 1510
 18 X 25 CM.
 KEUFFEL & ESSER CO.
 MADE IN U.S.A.

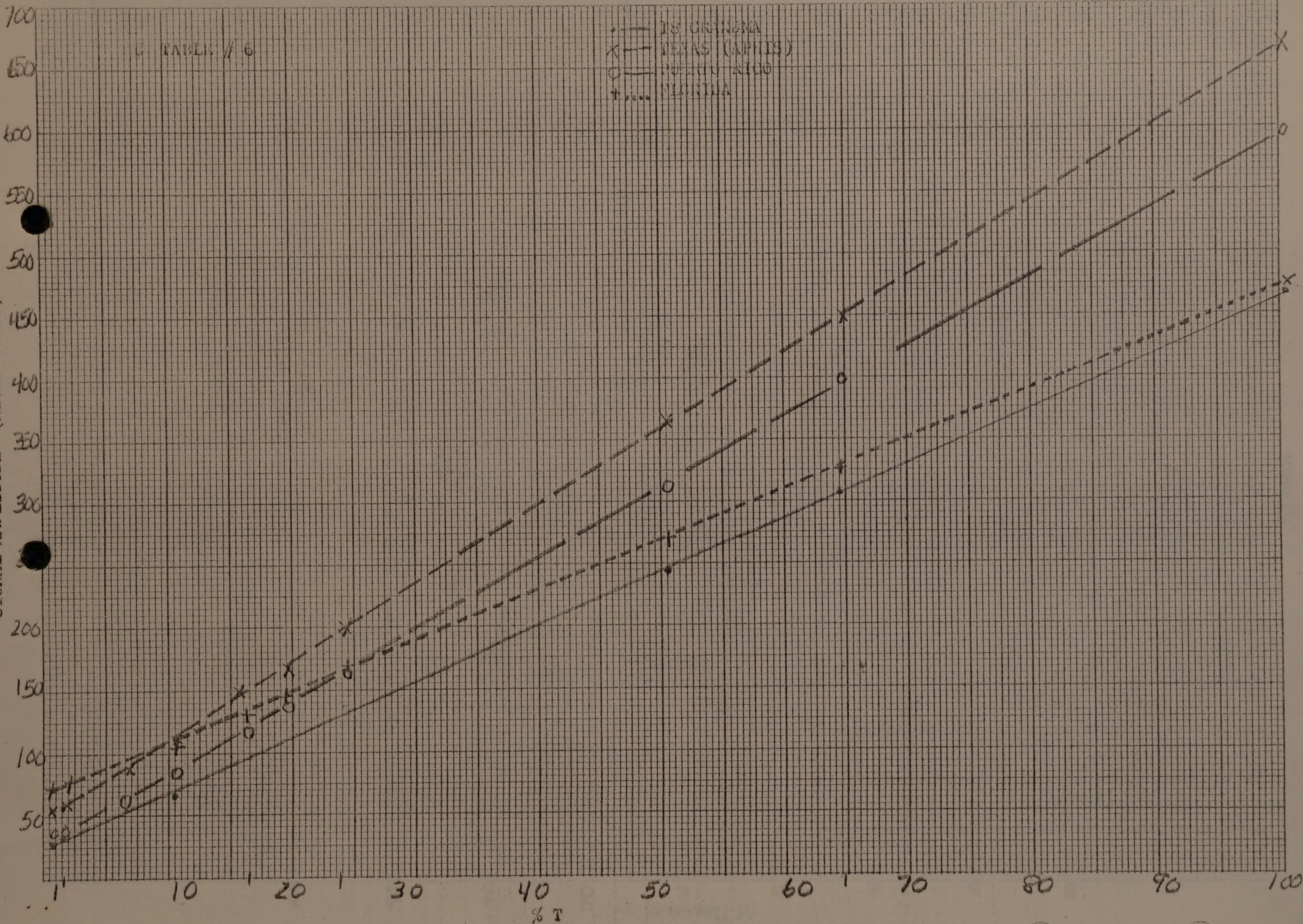


OVER-ALL ERG HEIGHT

TABLE # 6

- IS GUNNARA
- x TEXAS (APHIS)
- o PUERTO RICO
- + FLORIDA

SIGNAL AMPLITUDE (MICRO-VOLTS)



MADE IN USA

AQUADEE

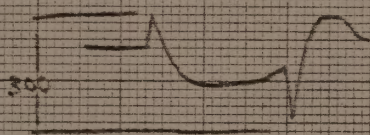
DRAWING PAPER NO. 1280-20
TRACING PAPER NO. 1227-20
GROSS SECTION-20X20 TO 1 INCH

TABLE # 7

SCREW-WORM ADULT

LIGHT INTENSITY REQUIRED TO EVOKE
A TOTAL HEIGHT ERG OF 300
MICRO-VOLTS

$$\lambda = 550 \text{ nm}$$
$$100\% T = 98.2 \times 10^{-2} \text{ MWATTS/CM}^2$$



% TRANSMISSION

100

90

80

70

60

50

40

30

20

10

TEXAS (CPHIS)

PUERTO RICO

FLORIDA

18 GRANDMA

STRAIN

ON RESPONSE
LINEAR REGRESSION

TABLE # 8

•—— IS GRANDMA
X--- TEXAS (APHS)
○—— PUERTO RICO
+---- FLORIDA

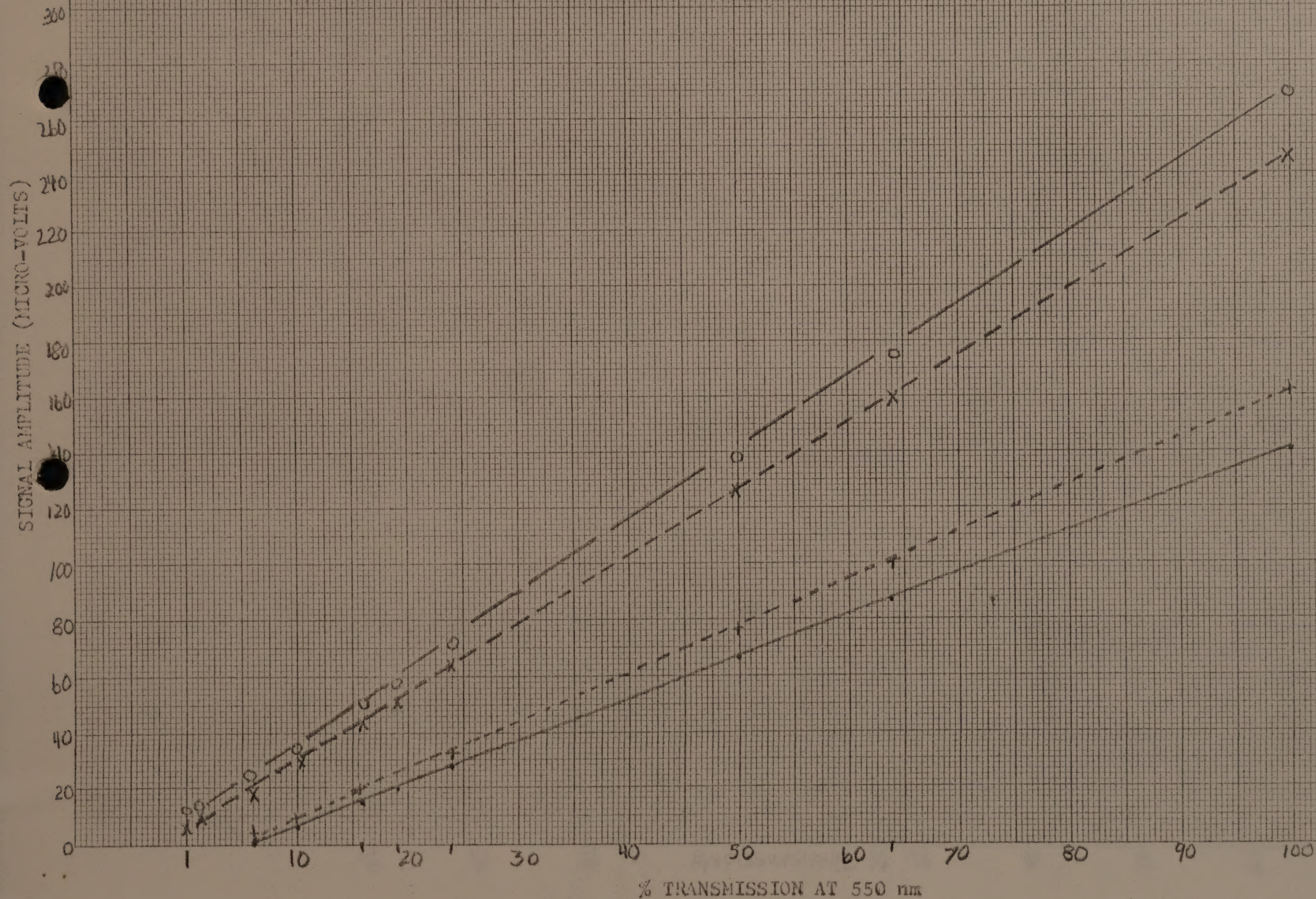


TABLE # 8a

100

90

80

70

60

50

40

30

20

10

% TRANSMISSION

18 GRAND MA

TEXAS (APHS)

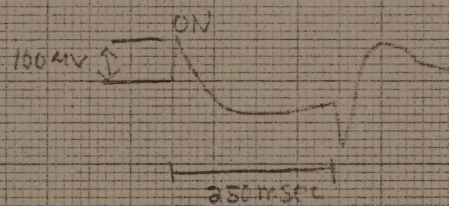
PORTO RICO

FLORIDA

STRAIN

LIGHT INTENSITY REQUIRED AT 560NM
TO EVOKE A ON RESPONSE
OF 100 MICRO-VOLTS

$$100\% T = \frac{99.2 \times 10^{-2}}{14 \text{ WATTS/CM}^2}$$



NEGATIVE PLATEAU
LINEAR REGRESSION
TABLE # 9

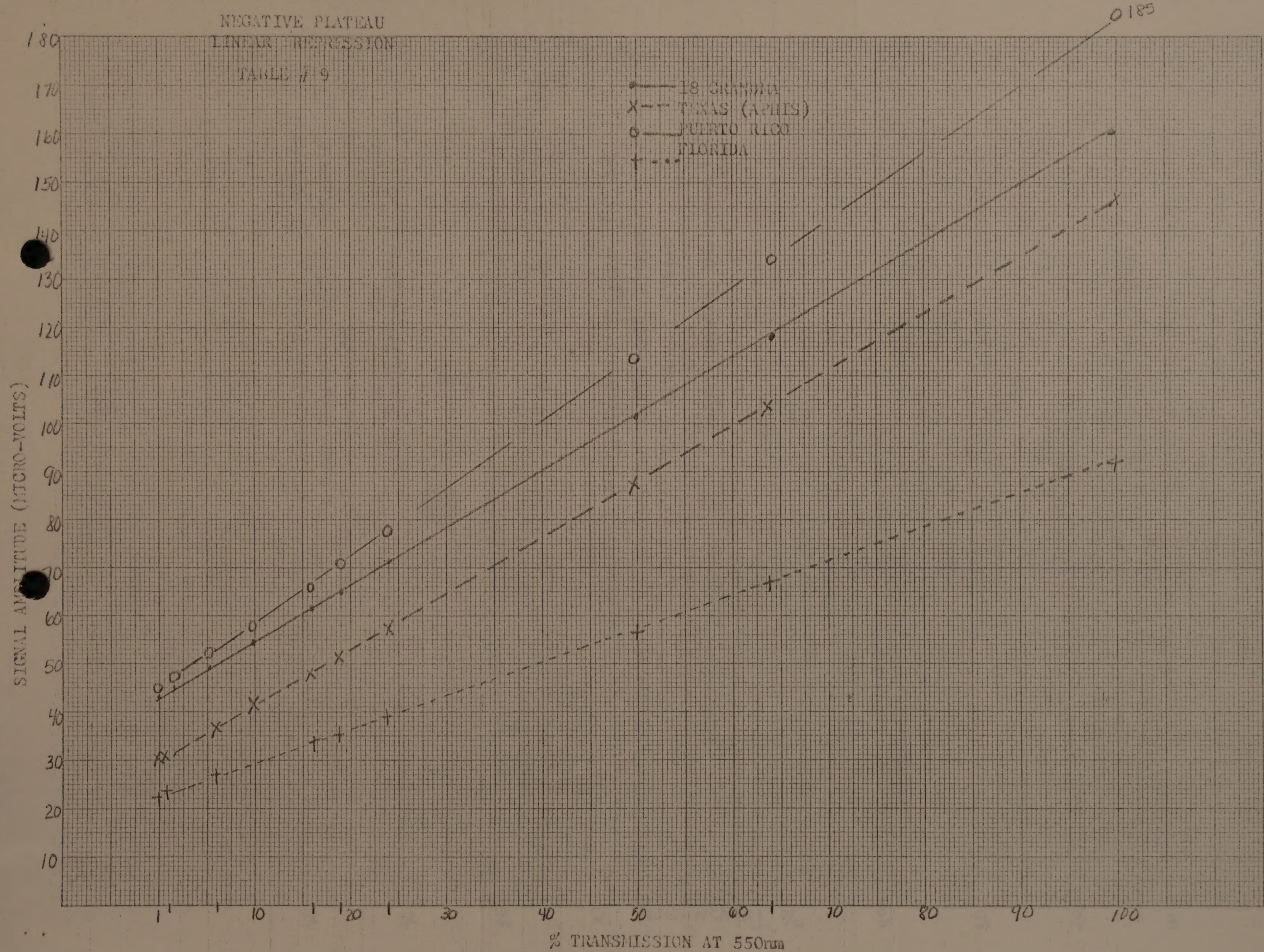
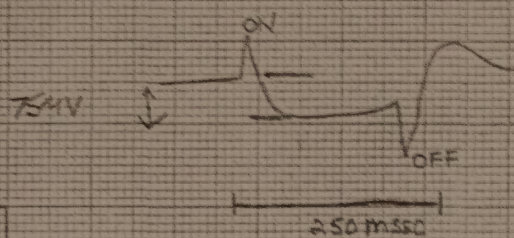


TABLE # 9A

100
90
80
70
60
50
40
30
20
10

LIGHT INTENSITY REQUIRED AT 550 NM
TO EVOKE A NEGATIVE PLATEAU RESPONSE
OF 75 MICRO-VOLTS.

$$100\% T = 98.2 \times 10^{-2} \text{ MWATTS / CM}^2$$



* STATICALLY SHOWN TO BE
DIFFERENT THAN
THE OTHER 3 STRAIN
(SIGNIFICANCE UNKNOWN)

% TRANSMISSION

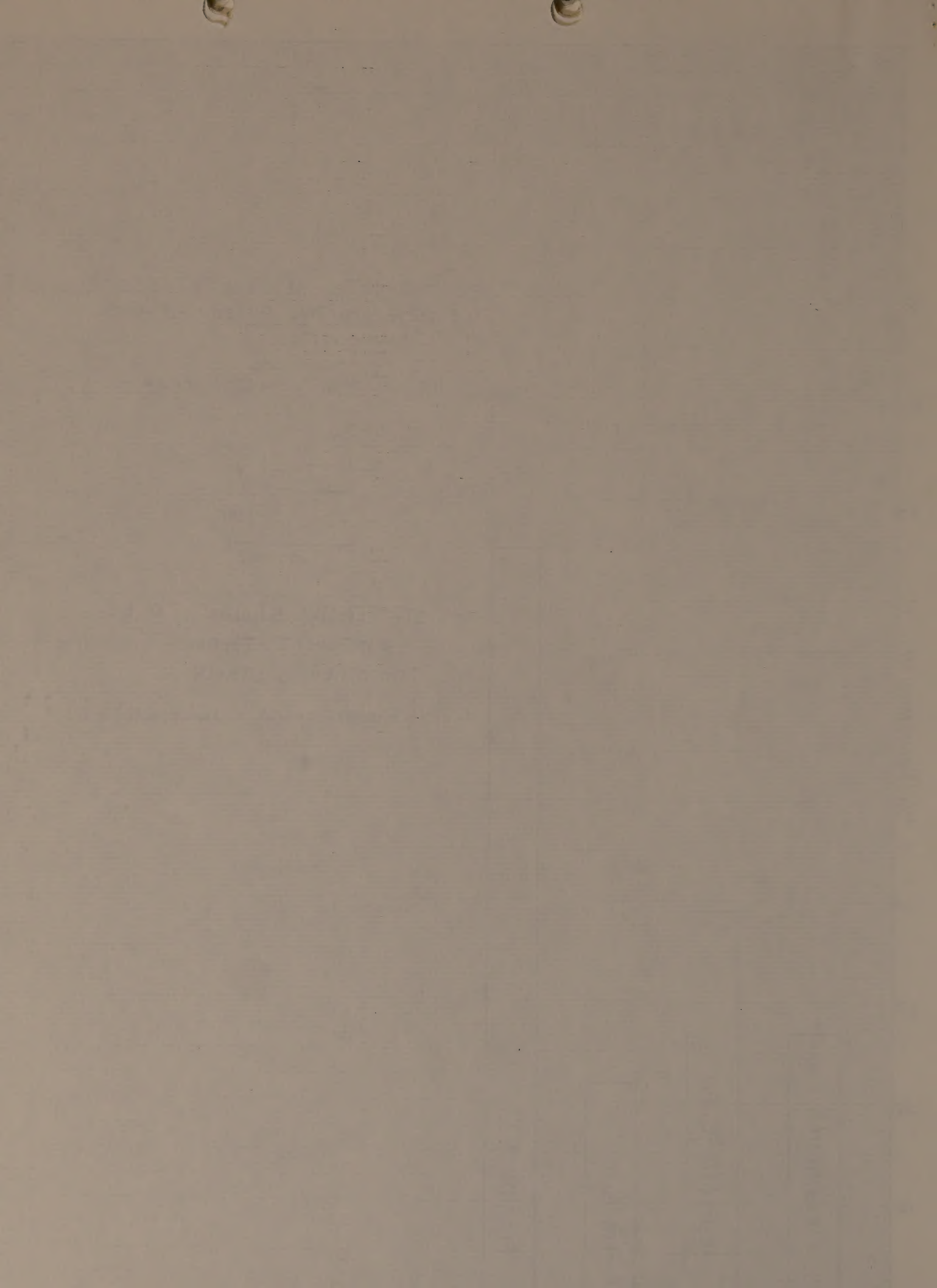
18 GRANDMA

TEXAS (APHIS)

PUERTO RICO

FLORIDA *

STRAIN



OFF RESPONSE
LINEAR REGRESSION

- — IS GRANDMA
- x — TEXAS (APHIS)
- o — PUERTO RICO
- + — FLORIDA

TABLE # 10

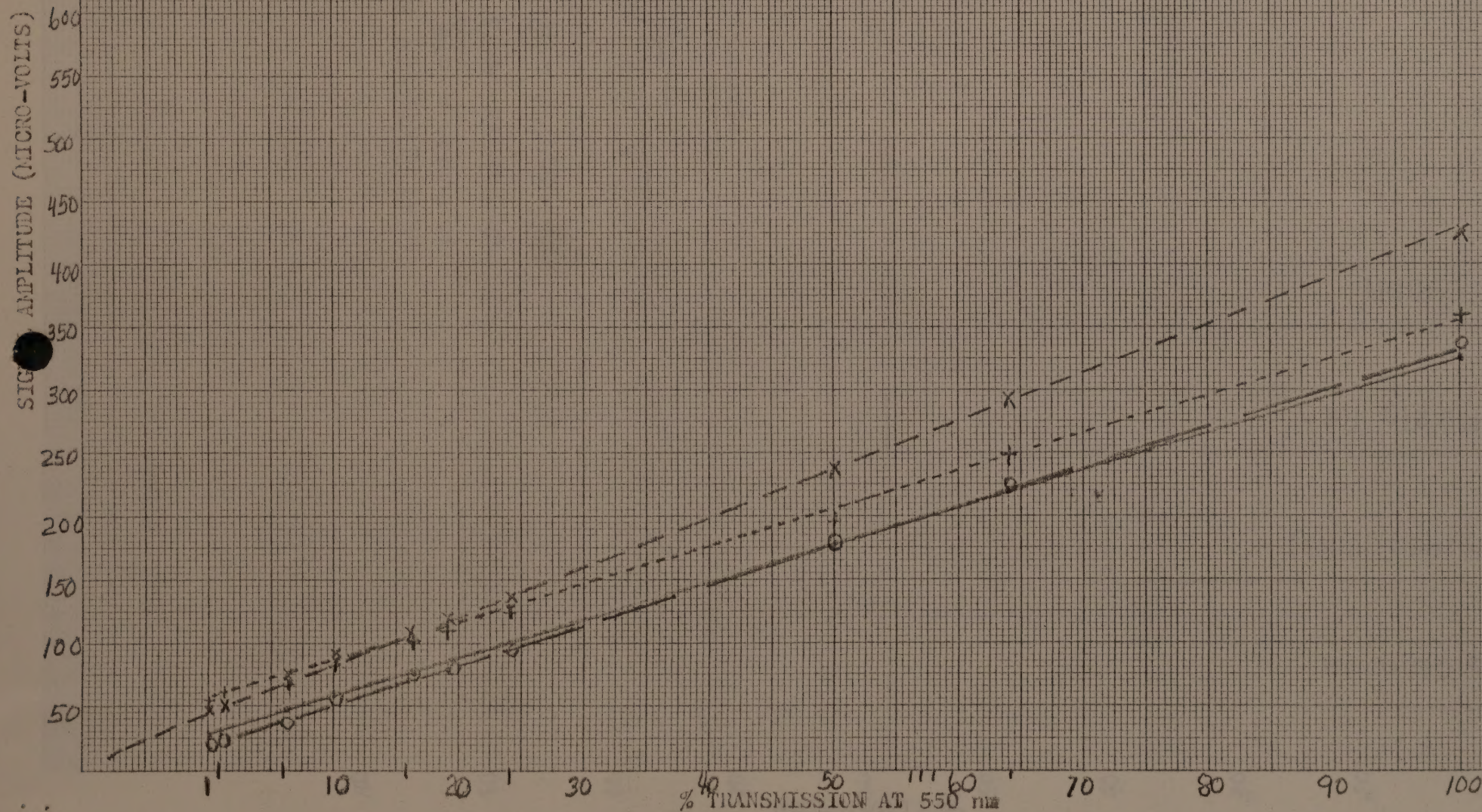


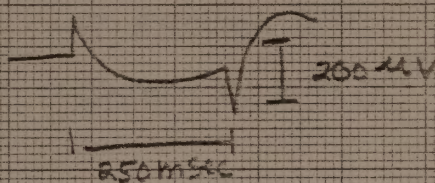
TABLE # 10a

100
90
80
70
60
50
40
30
20
10

% TRANSMISSION

LIGHT INTENSITY REQUIRED AT 550 nm
TO EVOKE A OFF RESPONSE OF
200 MICRO-VOLTS

$$100\% T = 98.2 \times 10^{-2} \text{ WATTS/cm}^2$$



18 GRANDMA

TEXAS (PHIS)

PUERTO RICO

FLORIDA

STRAIN

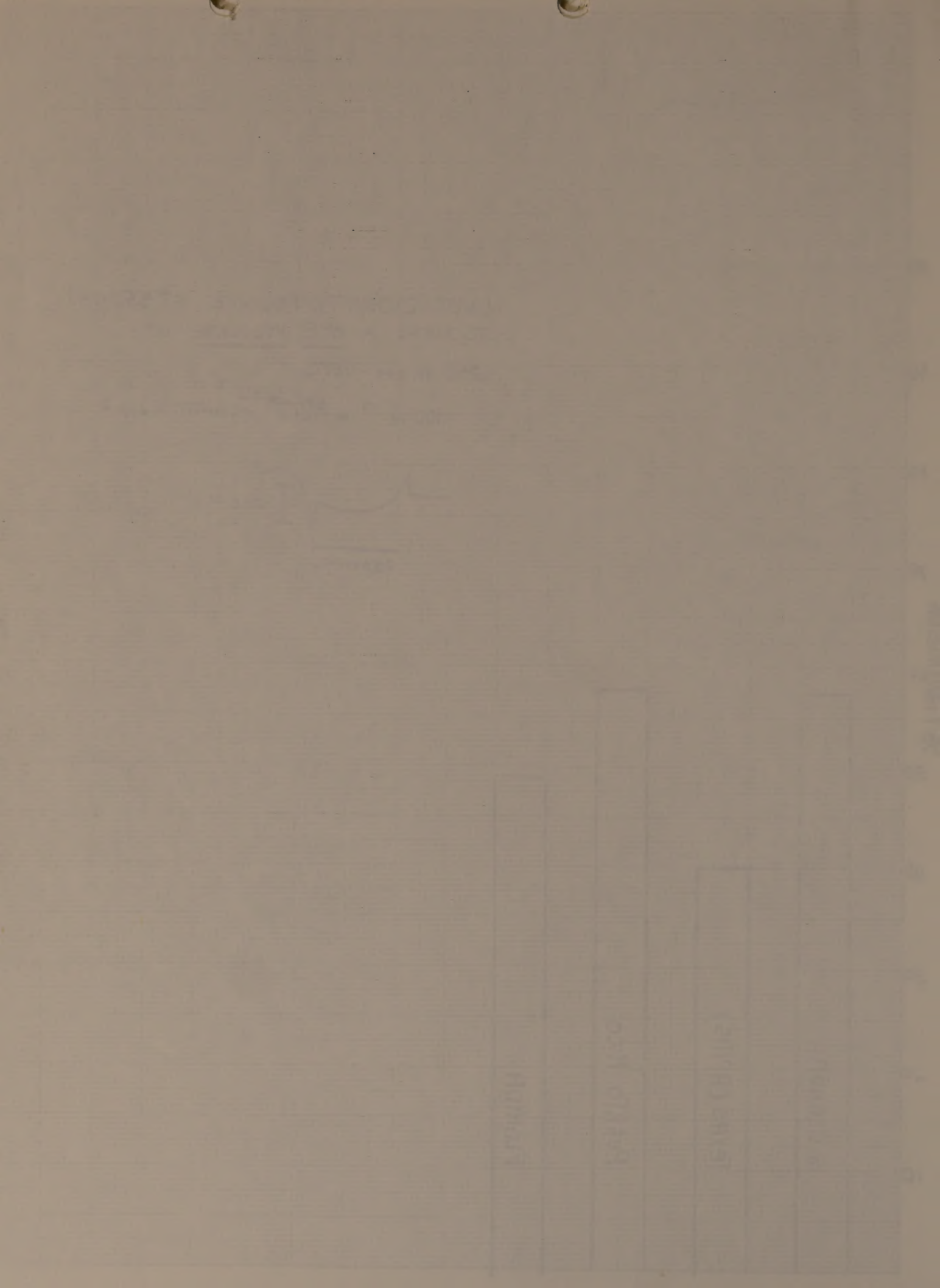


TABLE # 11

FLASHES/SEC

SCREW-WORM ADULT

FLICKER FUSION FREQUENCY
AT 550 NM λ

Intensity = 98.2×10^{-2} WATTS/CM²

18 GRANDMA

TEXAS (APHIS)

PUERTO RICO

FLORIDA

STRAIN

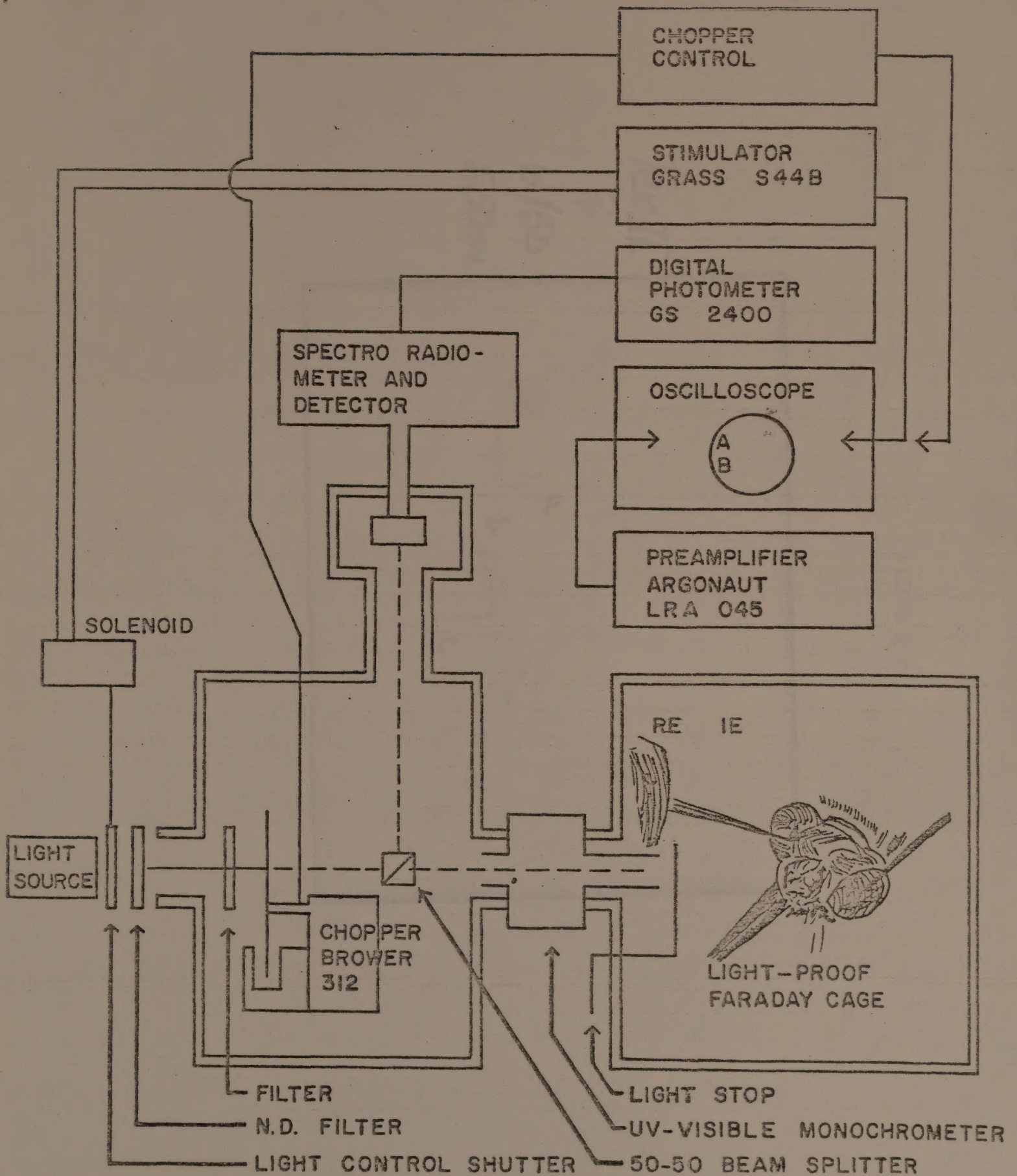
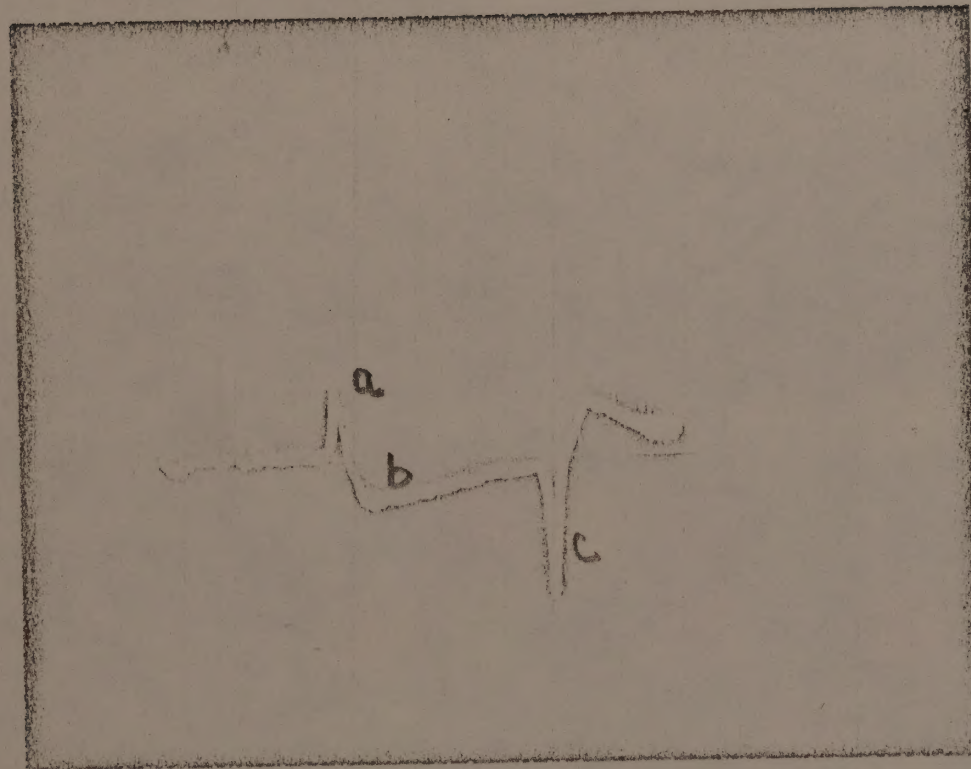


FIGURE # 2

Tex II
♀
6/30
550mu



File

Plant and Entomological Sciences
Beltsville, Maryland 20705

July 30, 1973

Subject: Screwworm Colonies

To: R. C. Bushland
Screwworm Research Laboratory
Mission, Texas

Thank you for the details in the rough draft copy that you sent to Dr. Klassen and me on July 13. We have also received copies of the proposal which Mr. Taylor developed on the basis of your background material.

When Dr. Klassen returned from travel I briefed him on our conference with Dr. Knipling and on some other matters that have been occurring relative to the screwworm situation. I also informed him of the proposed work conference that you and Mr. Taylor would like to have later on. When you decide on a tentative time I would suggest that you check with us because we both have a rather heavy commitment of conferences and travel. I am sure, however, that we can find the time when we can all get together on such an important subject as you have proposed.

L. S. Henderson
Staff Scientist

cc:
Dr. Klassen
Mr. E. Taylor

8-7-73
Del Van Petersen called
requesting Jim Bates for
this conference. He was
to call Dr. Bushland to see
about this because he (Petersen)
has another commitment
last week of August. L.S.

RECEIVED

AUG 3 1973

AREA OFFICE
WESLACO, TEXAS

1. The first thing I noticed when I stepped out of the plane was the heat. It was a relief after the cool air of the plane.

July 10, 1973

Dear Mr. Tolson:

Enclosed for you are two copies of a letterhead memorandum (LHM) dated and captioned as above.

I am sure you will find this information of interest.

Sincerely,
J. Edgar Hoover

Thank you for the letter of July 10, 1973, regarding the LHM dated and captioned as above. We have also received your letter of July 11, 1973, regarding the LHM dated and captioned as above. We are currently reviewing the LHM and will respond to you as soon as possible.

When Mr. Tolson returned from travel I discussed the LHM with him. He indicated that he had been contacted by Mr. Tolson and on some other matters. I also discussed the LHM with Mr. Tolson and he indicated that he would like to have a copy of the LHM. I am currently reviewing the LHM and will respond to you as soon as possible. I am sure you will find this information of interest.

J. Edgar Hoover
Director

Mr. Tolson
Mr. DeLoach
Mr. Mohr
Mr. Bishop
Mr. Casper
Mr. Callahan
Mr. Conrad
Mr. Felt
Mr. Gale
Mr. Rosen
Mr. Sullivan
Mr. Tavel
Mr. Trotter
Tele. Room
Miss Holmes
Miss Gandy

[Handwritten notes in red ink, mostly illegible]

RECEIVED

AUG 13 1973

AREA OFFICE
WEST COAST TEXAS